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Great Lakes Steamers for Coastwise Service

During the past year the Great Lakes Engineering Works, Detroit, Mich., has built and delivered seven freight steamships for service in the Atlantic and Pacific coast trade. As the construction of ocean-going vessels is something of an innovation on the Great Lakes, these vessels have naturally attracted considerable attention.

The *Grayson*, *Borinquen*, *Yaguez* and *Bayamon* are owned and managed by the Ocean Freight Line, Inc., New York City,

FIG. 1.—FREIGHT STEAMER ROBERT M. THOMPSON, BUILT BY THE GREAT LAKES ENGINEERING WORKS FOR THE AMERICAN TRANSPORTATION COMPANY

and the *Thompson*, *Raven* and *Ruby* are owned by the American Transportation Company and managed by Thomas W. Elwell & Company, New York City. All of these vessels are sister ships and all are so constructed that they can be easily converted into oil-burning steamers in the event of their going into the Pacific Coast trade when the Panama Canal is opened for traffic. They were built under special survey to Lloyd's highest class, and have the following principal dimensions:

Length over all	261 feet.
Length between perpendiculars	253 feet.
Beam molded	43 feet 6 in.
Depth molded	28 feet 5 in.
Load draft	24 feet.
Deadweight at load draft	4,050 tons.
Total cargo capacity	189,000 cubic feet.
Total bunker capacity	500 tons.

The vessels have two complete steel decks extending the full length of the ship. There are also poop, bridge, forecastle and boat decks all built of steel. Access to the cargo holds is by four hatches, two being 18 feet by 15 feet, one 22 feet by 15 feet, and one 26 feet by 15 feet, and in the 'tween decks there are three cargo ports 8 feet 6 inches by 6 feet on each side and in the bridge space one cargo port 5 feet 6 inches by 6 feet on each side. The decks are all supported by girders and wide spaced pillar stanchions, leaving the holds as nearly as possible unobstructed.

The coal is carried in wing bunkers the full length of the machinery space and in a cross bunker forward of the boiler room. On the last four ships these bunkers are constructed

so that they can readily be arranged for fuel oil. The 'tween decks in way of the machinery space are arranged for either coal or cargo, having large watertight doors in the bulkheads at each end.

The quarters for the firemen and seamen are in the poop. The quarters for the officers and the remainder of the crew are all in a steel house on the bridge deck. The pilot house is located on the forward end of the boat deck and is of wood.

6-ton booms is all "durable wire rope." The 30-ton derrick has a 9-part fall and topping lift of plow steel wire.

The steering engine is located in the poop and geared direct to the quadrant, doing away with all the troubles which are attendant on chains and sheaves. The steering engine is controlled by a telemotor from the pilot house. There is a steam windlass on the forecastle deck with engines on deck below, and a steam capstan on the poop deck.

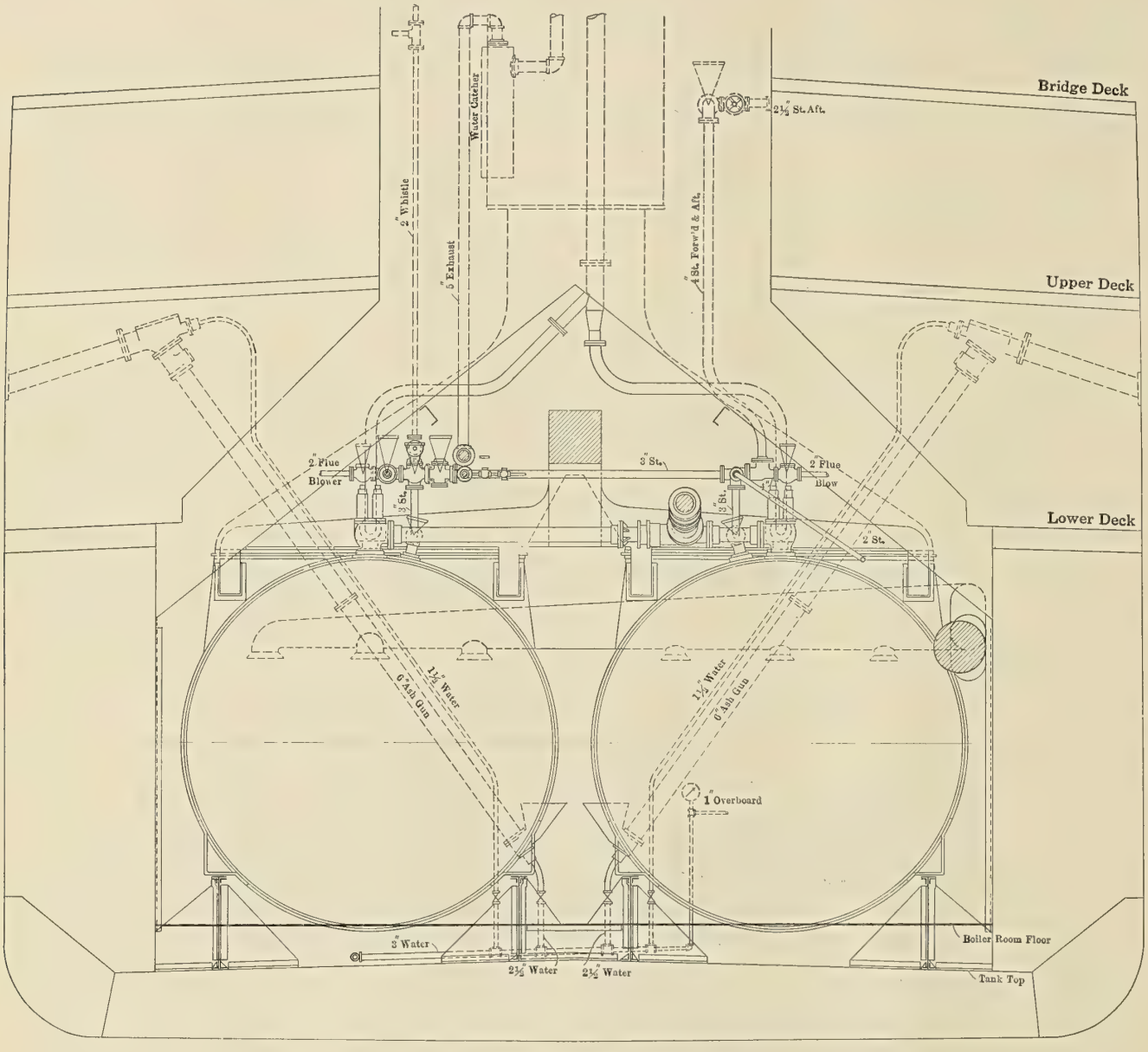


FIG. 2.—SECTION THROUGH BOILER SPACE

The quarters in the midship house are finished in oak. Aside from the interior finish of the cabins and the ceiling of the cargo holds, wood has been practically eliminated from these ships.

Deck Machinery

The cargo-handling gear is very complete. Each ship has two steel derrick masts. The foremast carries eight wood booms, each of 6 tons capacity and one steel boom with a capacity of 30 tons. The mainmast has seven wood booms of 6 tons capacity. There are eight cargo winches, all single drum with 8¼-inch by 10-inch cylinders. Two of the winches are double geared, of specially heavy construction for handling the 30-ton derrick. The standing rigging is all of galvanized plow steel wire rope. The running rigging for the

Boilers

Steam for all purposes is furnished at 180 pounds per square inch working pressure by two Scotch boilers, 14 feet 2 inches, mean diameter, 12 feet long over all. The shell plates are 1¼ inches thick, and each boiler has three 42-inch Morison furnaces made from material 35/64-inch thick. Each furnace has a separate combustion chamber, and there 323 2¾-inch tubes in each boiler.

The total heating surface of each boiler is 2,206.5 square feet, divided as follows: Tubes, 1,844 square feet; furnaces, 132.5 square feet; combustion chambers, 230 square feet. The grate surface of each boiler (with grate bars 5 feet long) is 52.5 square feet, making a ratio of heating surface to grate area, 42.02 to 1. Through the tubes the draft area is 10.8

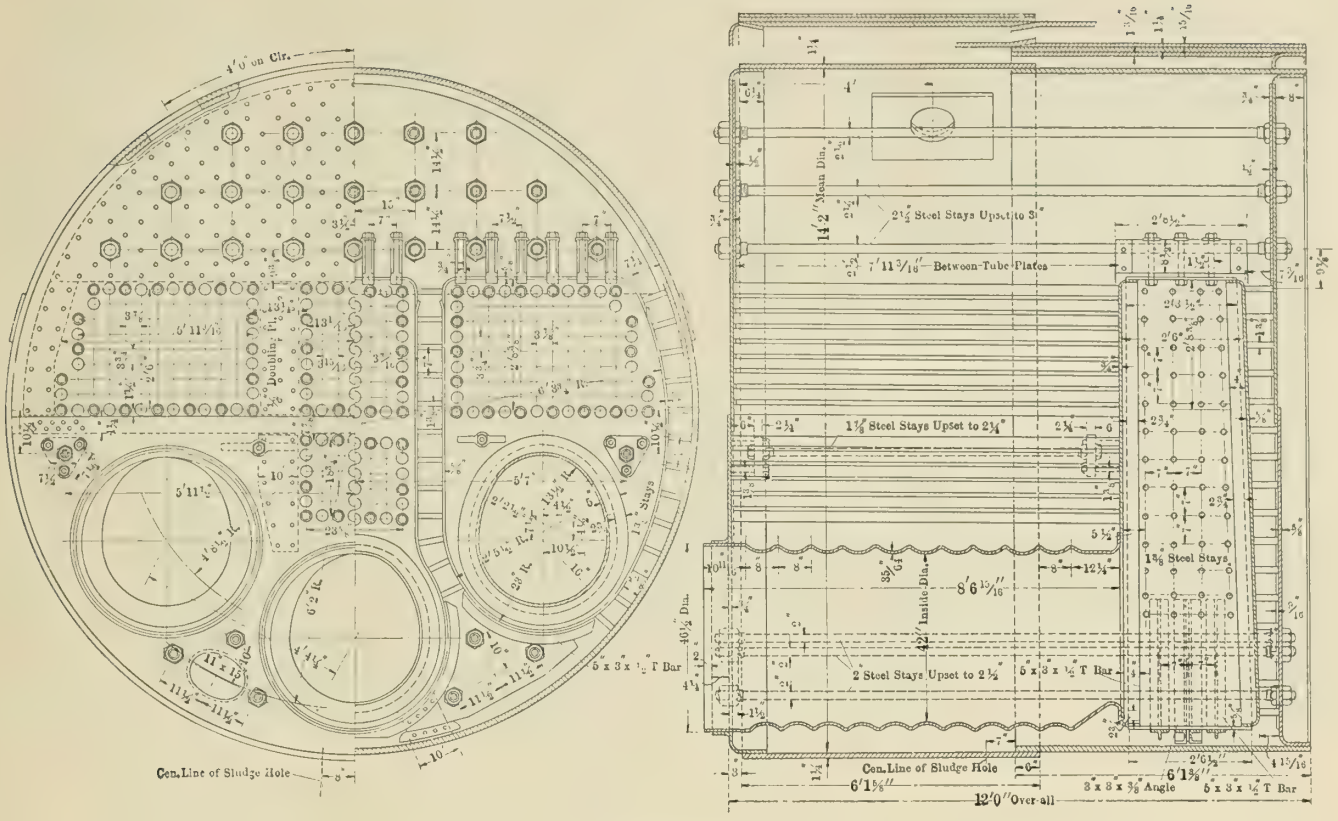

4'0" on Clr.
Double Riveted
Cen. Line of Sludge Hole
5 x 3 x ½" T Bar
2½" Steel Stays Upset to 3"
7'11 3/16" Between Tube Plates
1⅞" Steel Stays Upset to 2¼"
2 Steel Stays Upset to 2½"
1⅞" Steel Stays
8'6 15/16"
Inside Dia.
Cen. Line of Sludge Hole
6'1⅝"
6'1⅝"
12'0" Over all
3 x 3 x ⅜ Angle
5 x 3 x ½" T Bar

FIG. 3.—BOILER

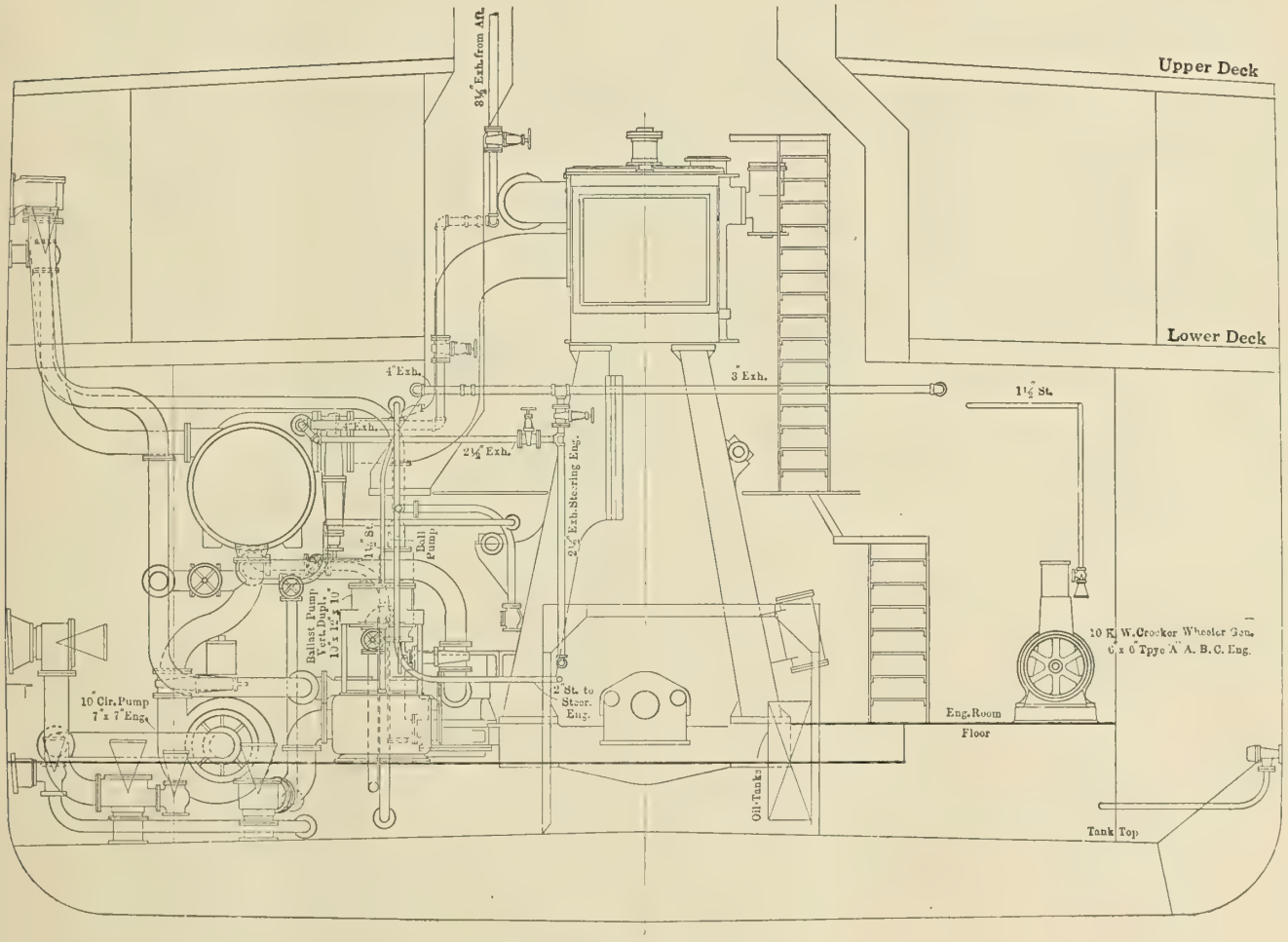


FIG. 4.—SECTION THROUGH ENGINE ROOM

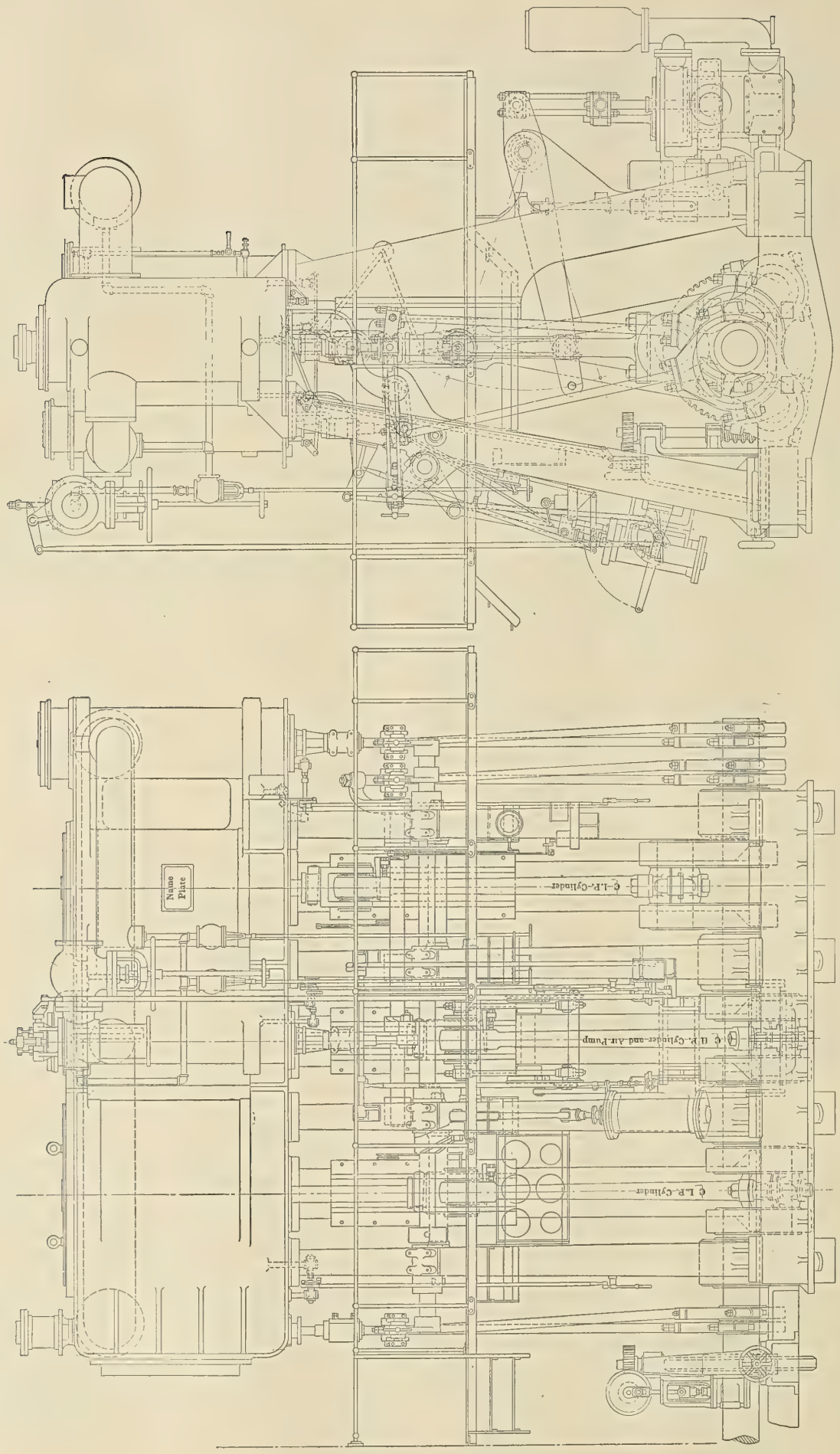


FIG. 5.—TRIPLE-EXPANSION ENGINE OF 1,480 HORSEPOWER FOR LAKE-BUILT COASTWISE STEAMSHIPS

FIG. 6.—A. A. RAVEN ON THE LAUNCHING WAYS

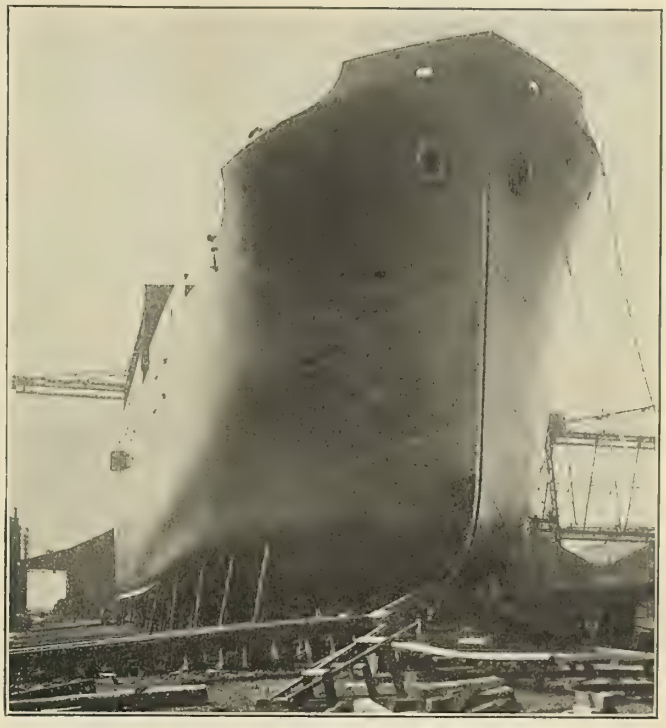


FIG. 8.—BOW VIEW OF THE RAVEN

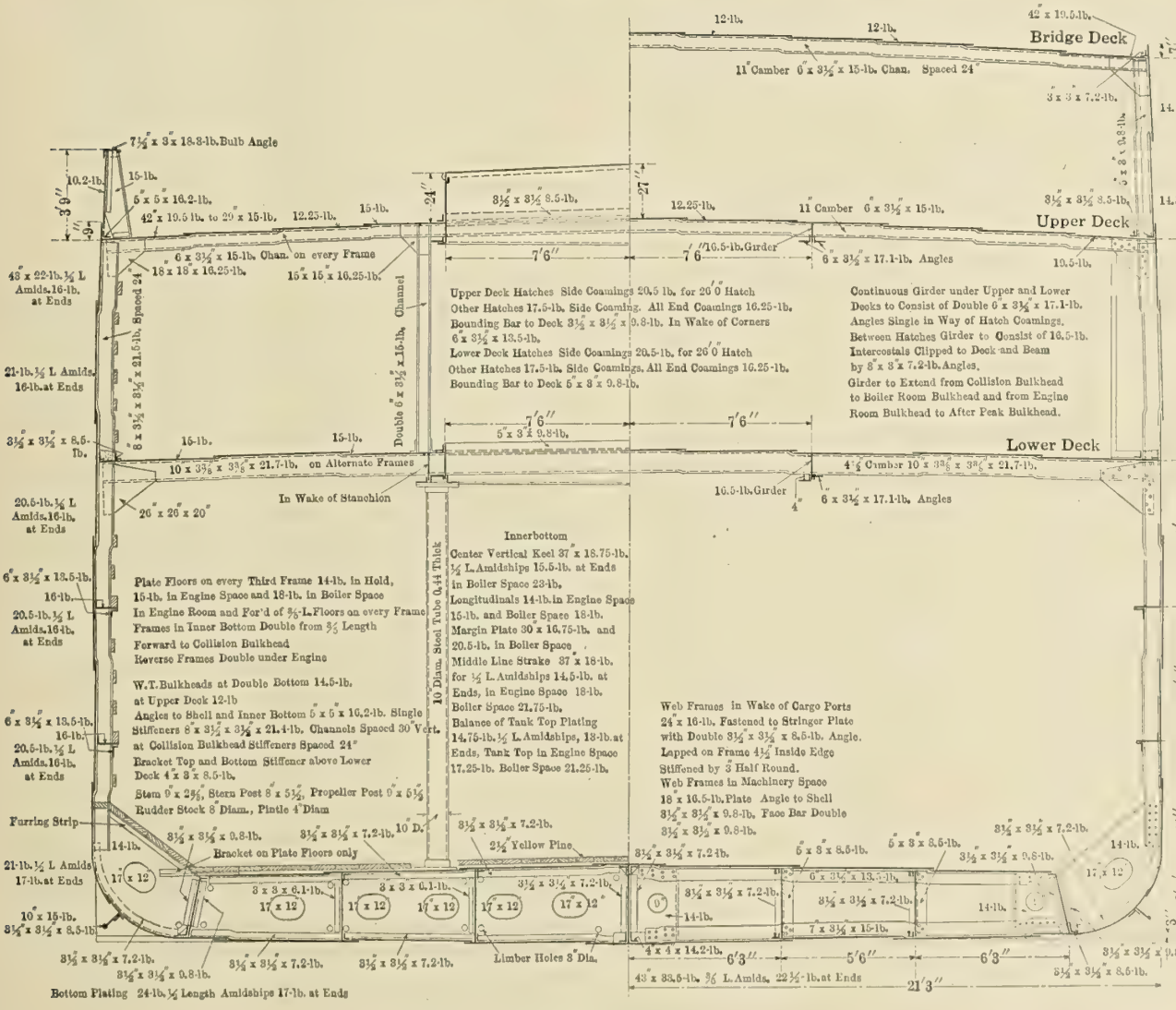

Bridge Deck
Upper Deck
Lower Deck
11" Camber 6" x 3½" x 15-lb. Chan. Spaced 24"
42" x 19.5-lb.
3" x 3" x 7.2-lb.
14.5-lb.
3½" x 3½" x 8.5-lb.
12.25-lb.
11" Camber 6" x 3½" x 15-lb.
7'6"
7'6"-16.5-lb. Girder
6" x 3½" x 17.1-lb. Angles
19.5-lb.
6 x 3½" x 15-lb. Chan. on every Frame
18" x 18" x 16.25-lb.
15" x 15" x 16.25-lb.
Double 6" x 3½" x 15-lb. Channel
Upper Deck Hatches Side Coamings 20.5 lb. for 26'0" Hatch
Other Hatches 17.5-lb. Side Coaming. All End Coamings 16.25-lb.
Bounding Bar to Deck 3½" x 3½" x 9.8-lb. In Wake of Corners
6" x 3½" x 13.5-lb.
Lower Deck Hatches Side Coamings 20.5-lb. for 26'0" Hatch
Other Hatches 17.5-lb. Side Coamings. All End Coamings 16.25-lb.
Bounding Bar to Deck 5" x 3" x 9.8-lb.
Continuous Girder under Upper and Lower Decks to Consist of Double 6" x 3½" x 17.1-lb. Angles Single in Way of Hatch Coamings. Between Hatches Girder to Consist of 16.5-lb. Intercostals Clipped to Deck and Beam by 3" x 3" x 7.2-lb. Angles.
Girder to Extend from Collision Bulkhead to Boiler Room Bulkhead and from Engine Room Bulkhead to After Peak Bulkhead.
5" x 3" x 9.8-lb.
10 x 3⅜" x 3⅜" x 21.7-lb. on Alternate Frames
4½" Camber 10 x 3⅜" x 3⅜" x 21.7-lb.
16.5-lb. Girder
6" x 3½" x 17.1-lb. Angles
In Wake of Stanchion
26" x 26" x 20"
Innerbottom
Center Vertical Keel 37" x 18.75-lb.
½ L. Amidships 15.5-lb. at Ends
in Boiler Space 23-lb.
Longitudinals 14-lb. in Engine Space
15-lb. and Boiler Space 18-lb.
Margin Plate 30" x 16.75-lb. and
20.5-lb. in Boiler Space
Middle Line Strake 37" x 18-lb.
for ½ L. Amidships 14.5-lb. at
Ends, in Engine Space 18-lb.
Boiler Space 21.75-lb.
Balance of Tank Top Plating
14.75-lb. ½ L. Amidships, 18-lb. at
Ends, Tank Top in Engine Space
17.25-lb. Boiler Space 21.25-lb.
10" Diam. Steel Tube 0.44 Thick
Plate Floors on every Third Frame 14-lb. in Hold,
15-lb. in Engine Space and 18-lb. in Boiler Space
In Engine Room and For'd of ⅗ L. Floors on every Frame
Frames in Inner Bottom Double from ⅗ Length
Forward to Collision Bulkhead
Reverse Frames Double under Engine
W.T. Bulkheads at Double Bottom 14.5-lb.
at Upper Deck 12-lb
Angles to Shell and Inner Bottom 5" x 5" x 16.2-lb. Single
Stiffeners 8" x 3½" x 3½" x 21.4-lb. Channels Spaced 30" Vert.
at Collision Bulkhead Stiffeners Spaced 24"
Bracket Top and Bottom Stiffener above Lower
Deck 4" x 3" x 8.5-lb.
Stem 9" x 2⅝", Stern Post 8" x 5½", Propeller Post 9" x 5⅛"
Rudder Stock 8" Diam., Pintle 4" Diam
Web Frames in Wake of Cargo Ports
24" x 16-lb. Fastened to Stringer Plate
with Double 3½" x 3½" x 8.5-lb. Angle.
Lapped on Frame 4½" Inside Edge
Stiffened by 3" Half Round.
Web Frames in Machinery Space
18" x 16.5-lb. Plate Angle to Shell
3½" x 3½" x 9.8-lb. Face Bar Double
3½" x 3½" x 9.8-lb.
Bracket on Plate Floors only
2½" Yellow Pine
Furring Strip
Limber Holes 3" Dia.
Bottom Plating 24-lb. ½ Length Amidships 17-lb. at Ends
43" x 33.5-lb. ⅝ L. Amids. 22½-lb. at Ends
6'3"
5'6"
6'3"
21'3"

FIG. 7.—MIDSHIP SECTION

square feet, which makes the ratio of draft area to grate area 1 to 4.86.

Steam is conveyed to the main engines through pipes 8 inches in diameter, fitted with 6-inch stop valves. The auxiliary stop valves are 3 inches diameter. The boilers are so arranged that they can be fired directly from the 'thwartship bunker forward of the boiler room.

Main Engines

The ships are all single screw vessels, driven by a four-bladed propeller, 14 feet 3 inches diameter, having a variable pitch 14 feet 9 inches at the tip and 13 feet 9 inches at the hub. The developed area of the propeller is 68 square feet.

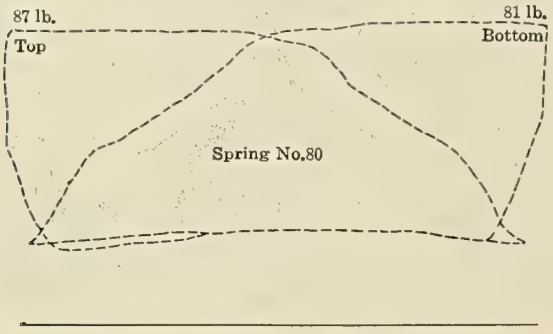


FIG. 9.—H.-P. CYLINDER. I. H. P., 524

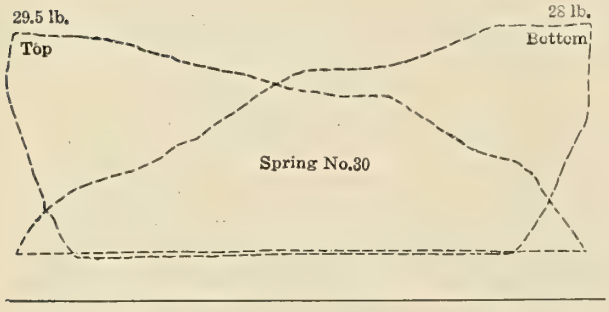


FIG. 10.—I.-P. CYLINDER. I. H. P., 489

The main engines are of the vertical inverted triple expansion type with cylinders 21½ inches, 35½ inches and 58 inches diameter, with a common stroke of 42 inches. At a speed of 83 revolutions per minute it is estimated that the engines will develop 1,480 horsepower.

In the arrangement of the cylinders the intermediate-pressure cylinder is placed forward; following this is the high-pressure cylinder, and aft is the low-pressure cylinder; the crank sequence being high-pressure, low-pressure, intermediate-pressure. Both the high-pressure and intermediate-pressure cylinders are fitted with piston valves and the low-pressure cylinder has a double-ported slide valve to the spindle of which a balance piston is attached. The high-pressure piston has deep removable solid followers, and the intermediate and low-pressure piston have special metal packing rings.

All the piston rods are 5 inches diameter. Annealed cast steel is used for the crossheads, and these are fitted with brass slippers for ahead and backing faces. The crosshead pins are 5¾ inches diameter by 8½ inches long. The connecting rods are of approved construction 8 feet 6 inches long center to center, made from open-hearth steel forgings. The diameter at the top is 4¾ inches and at the bottom 6 inches. Brass crosshead pin boxes are fitted with wedge adjustment. The crank pin boxes are of cast steel lined with Babbit and have bolt adjustment. All piston rods and valve stems are fitted with metallic packing.

The crank shaft is of the built-up type, having cast steel slabs which are shrunk on and doweled. The crank shaft is 11¾ inches diameter and the crank pins 11¾ inches diameter by 11½ inches long. The crank shaft is supported by four main bearings, two of which are 19 inches long and two 16 inches long.

The thrust shaft is also 11¾ inches diameter. It is fitted with five driving collars bearing against horseshoe-shaped Babbit-faced rings. The outboard shaft is 12 11/16 inches diameter in the body and 14¼ inches diameter in the stern bearing, which is 4 feet 4 inches long. The line shafting is 11 inches diameter in the body, enlarged to 11⅛ inches in the bearings, of which there are four.

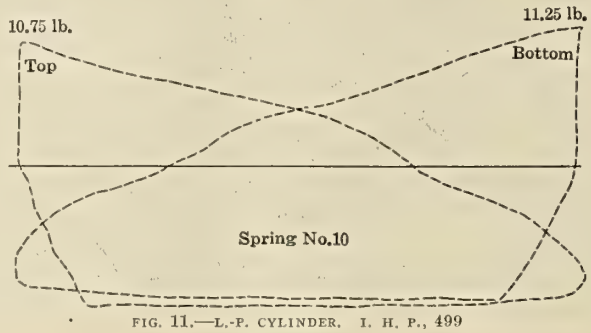


FIG. 11.—L.-P. CYLINDER. I. H. P., 499

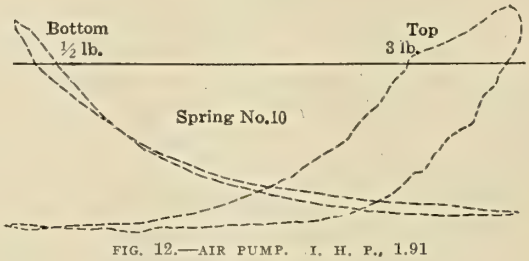


FIG. 12.—AIR PUMP. I. H. P., 1.91

Auxiliary Machinery

The auxiliary machinery includes a vertical duplex ballast pump 10 inches by 12 inches by 10 inches; a 10-inch centrifugal main circulating pump, driven by a 7-inch by 7-inch engine; a vertical duplex feed pump, 7½ inches by 4½ inches by 10 inches; a donkey vertical duplex pump, 10 inches by 6 inches by 10 inches; a horizontal duplex general service pump, 6 inches by 4 inches by 6 inches; and a horizontal duplex fresh water pump, 4½ inches by 3¾ inches by 4 inches. The bilge pump is attached to the main engine and has two cylinders 4½ inches diameter by 12 inches stroke. The air pump is also attached to the main engine and is driven from the high-pressure crosshead. It is a double-acting pump, 18 inches diameter by 10 inches stroke. There is also fitted to the main engine a direct connecting reverse cylinder 10 inches diameter by 24 inches stroke, and a 6-inch by 6 inch single cylinder turning engine. The main condenser has a cooling surface of 2,125 square feet.

Positive draft is furnished by a single blower having a 36-inch wheel, 38-inch suction and a 24-inch by 24-inch discharge. The blower is driven by a 5-inch by 5-inch engine. A feed water heater, 25 inches diameter by 4 feet 4½ inches long, is provided, and the ship is lighted throughout by electricity, current being obtained from a 10-kilowatt generator driven by a 6-inch by 6-inch engine.

Figs. 9, 10, 11 and 12 show indicator cards taken from the engine of the *Ruby* on trial trip: Boiler pressure, 180; vacuum, 22.5 inches; revolutions per minute, 81; piston speed, 567 feet per minute; mean effective pressure referred to low-pressure cylinder, 33.3 pounds per square inch, and total horsepower, 1,512.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER V

Engineering Materials

McAndrew, feeling somewhat encouraged at the interest which his class had shown during his remarks on elementary principles, decided that the next step in order would be to give them an idea of engineering materials, so he opened his remarks by saying: "Boys, what material is a cold chisel made from?" Three of them answered promptly, "Steel, sir." O'Rourke dissented somewhat by saying that he thought the one he had been using that day must have been made of lead, as he had to grind it so often. Paying no attention to the sally, the engineer pedagogue said: "Well, what is the difference between steel and iron?" As a deep silence followed the question, he remarked: "I thought you didn't know, and that's the reason I asked you. Since you have, I hope, absorbed a few ideas about elementary principles in engineering, I want to drill into you some idea of the materials used in building marine machinery.

"The first and most important of them is iron, man's most valuable metal." "What about gold, sir?" interjected O'Rourke. "I'm glad you spoke about that, as it shows that you think what most other people do. As a matter of fact, we could get along very well without gold, but we would have hard sledding to get along without iron. Gold is only valuable because of its scarcity, while iron is valuable on account of its usefulness. Luckily, it is found in great quantities in almost all parts of the world, and as it would be practically impossible to build marine machinery without it, we will try and see what cast iron really is.

"Since the days of old Tubal Cain, iron has been mined and utilized by mankind for all kinds of implements. It exists in a number of different combinations known as ores, some containing as high as 75 percent of pure iron. The first process after it is taken from the ground is to separate the iron from the other substances, and this is done in what are known as blast furnaces. The scheme is to mix the iron ore with coal or other fuel and melt the whole mass down by means of forced combustion of the coal, hence the term 'blast furnace.' The molten iron being heavier than the other substances, is drawn off at the bottom of the furnace, and being liquid is run along channels in a bed of sand, known as the pig bed, into depressions or molds in the sand about 3½ feet long, 6 inches wide and 4 or 5 inches deep. When these are cold they are known as 'pigs,' and thus we have the raw material known as pig iron.

"Pig iron, of course, varies in quality, as it is affected largely by the impurities of the coal, such as sulphur, silicon, etc., which get mixed with it during the melting process. In olden days, before wood became so scarce, and there were no Pinchots to say 'Woodman, spare that tree,' iron ore was melted down with charcoal, and consequently not so many impurities entered into the pig iron. That metal was then known as charcoal iron, and you can yet hear old timers bemoan the fact that they get so little of it these days. And it is a fact that genuine charcoal iron is now very scarce indeed. However, we get along quite well without it by having learned to make steel better and cheaper than the pioneers could.

"Now that you know something about cast iron, we will see for what purposes it is used on board ship. You all probably know that the cylinders are made of cast iron, always have been and always will be, as it cannot be improved upon for the purpose. It has sufficient strength to withstand the strain, will not melt or change under the heat, is readily machined, can be made into almost any form, becomes very smooth on wearing surfaces, and, above all, is very reasonable in price. That combination of qualities can never be excelled by any known metal."

"How strong is cast iron?" said Pierce.

"That's a good question," was the reply. "As I told you before, everything to be measured must have some standard of comparison. In the case of cast iron, the usual standard is what is known as its tensile strength per square inch. That means the number of pounds it would take to pull a bar one inch square, or one square inch in section, until it breaks. It is placed in a testing machine, which works very much on the principle of a beam weighing machine, and the weight or strain is gradually applied until the test piece breaks in two. The strength of the metal varies according to its quality and treatment, and its quality usually depends on the amount of impurities contained in the metal.

"First-class iron, such as used in cylinders, frequently has a tensile strength between 25,000 and 30,000 pounds per square inch. Other and poorer grades, such as are used in grate bars, furnace fittings, etc., have a strength of only 10,000 to 15,000 pounds to the square inch.

"Rigidity is the main feature of cast iron, and other tests, such as crushing and bending, are given to it, yet for all practical purposes the marine engineer is satisfied to know that it has the required tensile strength, as that is generally a guarantee that it will withstand any crushing or bending strains that will be placed upon it.

"Bedplates and condenser shells or walls are made of cast iron of fairly good quality, but need not be of such good material as that used for the cylinders. Guides, pistons, etc., are usually made of the best quality of iron.

"What is wrought iron, did you say? That's something you hear about, but very seldom see these days. Strictly speaking, wrought iron is literally pure iron, or iron with all other ingredients removed. Before we knew so much about steel making there were large quantities of wrought iron used about a ship; in fact, the ship's hull itself was built of it. The process of making it was to melt cast iron in what was known as a reverberatory furnace—that is, a furnace where the iron came in contact with the flame but not the fuel. By this means the carbon, etc., was burned out of the molten mass as well as could be, and men called puddlers stuck a bar into the boiling iron, rolled up a ball of it, like you would taffy, put it under a squeezer or hammer to squeeze out the dross, then either hammered or rolled it out into bars or sheets. This material could be forged, welded or rolled into almost any shape desired. The process of its manufacture was slow and expensive, and it has now been practically abandoned.

"Before I go any further I want to impress upon you the main distinction between cast iron, wrought iron and steel. Remember these fundamental facts and you will have the general idea:

"1. Wrought iron is pure iron with very little or no carbon in it.

"2. Steel is pure iron mixed with from one-tenth of one percent to sometimes one and two-tenths percent of carbon, according to the grade of steel required.

"3. Cast iron is iron mixed with about 3½ percent of carbon,

* Engineer-in-Chief, U. S. Revenue Cutter Service.

and with certain combinations even a higher percentage than that.

"You will thus see that the main distinction between these different grades of material is the amount of carbon they contain. To be sure, there are other ingredients in the mixture, such as sulphur, manganese and silicon in varying quantities. Sulphur is always bad, but certain small amounts of manganese and silicon are beneficial."

"What is this malleable iron we hear about?" inquired Pierce of the instructor.

"Malleable," replied McAndrew, "means capable of being hammered or rolled into shape, and although it sounds very good when applied to cast iron, you don't want to hammer it too vigorously or you will find that it will take the shape of two or three separate pieces, such as that two-inch elbow I saw O'Rourke wrestling with this afternoon."

"I didn't think you was looking when I busted that elbow," replied the guilty one.

"I saw it all right, and let that be a lesson to you that all malleable iron is not as 'malleable' as you might imagine.

"In making iron castings malleable, they are packed in some substance, such as mill scale or sand which will not melt, heated to red heat and allowed to stand for a number of days, during which time some of the carbon is withdrawn from the surface of the castings, which to a certain extent makes them tougher and more ductile. This process is used principally for small castings, such as pipe fittings. Some people claim that malleable iron can be welded; so, to demonstrate whether that claim is true or not, I'll have O'Rourke weld up that elbow he broke."

"Gee! I wish you would let me buy a new one instead," pleaded the Irish lad. "I'm not much on this scientific dope."

"To return to the subject," said McAndrew, "we will next take up the subject of steel, as used for shipbuilding.

"There are two principal processes used in the manufacture of structural steel, the Bessemer and open-hearth. As Bessemer steel is not used in any part of a ship, it will suffice to discuss the open-hearth process.

"This consists essentially of melting pig iron, scrap steel and wrought iron in a large circular furnace, sometimes as large as 20 feet in diameter, the heat being furnished by the combustion of gas over the top of the metal, so that, unlike a blast furnace, the fuel does not come in contact with the metal. This results in burning out the carbon in the mixture to a degree slightly less than that required in the steel to be made. In order to get the exact proportion of carbon required in the mixture, a certain amount of 'spiegel-eisen' is added."

"What's that, sir?" inquired O'Rourke.

"Ask your German friend," replied McAndrew.

"I don't know just what 'spiegel-eisen' is," replied Schmidt, "but in German it means looking-glass iron."

"That's right," said the instructor. "It gets its name from its bright surface, and it is really an iron ore containing a large proportion of manganese. This manganese unites with the oxygen and sulphur in the mixture and removes them. Spiegel-eisen also adds the requisite amount of carbon to the mixture. After it is determined by the man in charge of the furnace that the desired mixture is reached, the molten steel is run into ladles, from which it is poured into large molds which shape the metal into huge blocks of steel known as ingots. These ingots are, when needed, heated in a fiery retort to almost a white heat, and run back and forth through rolls until they are shaped into what are known technically as slabs and billets. In that shape they are selected to fill orders for boiler or ship plates and engine forgings, such as shafting, piston and connecting rods, columns, valve stems, etc."

"How can you tell this open-hearth steel from wrought iron?" inquired Nelson.

"Easy enough," interjected O'Rourke, "ask the man you buy it from!"

"That would be all right," said McAndrew, "if he knew the difference himself. As a matter of fact, it is very difficult to tell from appearances. Some people claim that they can tell by looking at it, but I have my doubts as to that. Others who are expert in working iron and steel can be reasonably sure by the way they cut. I remember once of being in doubt whether a certain lot of boiler tubes were of wrought iron or mild steel, and I could find no one who was absolutely sure as to the material of which they were made. There is one infallible way, however, of telling, and that is by cutting the metal in two, polishing up the surface and pouring on a little nitric acid. In wrought iron there is bound to be a certain amount of slag in the mixture which strings out in the rolling process and gives the metal the appearance of having a grain. When nitric acid is applied, the pure iron is eaten away and leaves the grain sticking above the surface. Steel being practically a homogeneous metal is eaten away uniformly by the acid.

"The next most important metal for marine machinery is brass, and I'll ask O'Rourke to tell you what it is."

Clearing his throat and assuming an air of importance at being called upon for an expert opinion, the son of Erin replied: "Brass is a metal that is mined—I don't know just where; it costs like blazes, smells bad, is 'pisonous' to the skin, gets dirty in five minutes, and is used around an engine room principally for the purpose of keeping the poor firemen busy shining it up when they ought to be resting themselves."

"That certainly is a very lucid description, and coming from such an expert on 'brass' it will have great weight. However, I cannot agree with all your conclusions, and especially as to its being mined.

"Brass, as it is commonly termed, is not an elementary metal, as it is composed of two and sometimes three elements, such combinations of two or more metals being known generally as alloys. An alloy composed of copper and zinc, or of copper, zinc and a very small amount of tin, is known as brass. When a larger proportion of tin or other metal, such as aluminum or lead, is used, the alloy is known as a bronze. As a matter of fact, the terms 'gun metal,' 'composition,' and 'bronze' are used rather loosely, and it is hard to draw a line of demarcation between them.

"The principal reasons for using brass, composition, bronze, etc., in the construction of marine machinery are their decreased friction when rubbed on other metals, their freedom from oxidization or corrosion, as it is commonly called, and in some instances for ornamentation. The latter reason is growing less every day, as there is plenty of other work on board a modern vessel to keep the firemen busy without having needless brasswork to polish.

"There are about a million different compositions of copper, tin, zinc, lead, antimony, iron, aluminum, etc., which can be made, but the principal ones of interest to marine engineers are the following, mixed in the proportions given:

"Common yellow brass: Copper, 65.3; zinc, 32.7; lead, 2.

"Babbit metal: Copper, 3.7; tin, 88.9; antimony, 7.4.

"Brazing metal: Copper, 84; zinc, 16.

"Admiralty bronze: Copper, 87; tin, 8; zinc, 5.

"Manganese bronze: Copper, 88.64; tin, 8.7; zinc, 1.57; iron, .72; lead, .30.

"Muntz metal: Copper, 60; zinc, 40.

"Navy composition: Copper, 88; tin, 10; zinc, 2.

"White metal: Lead, 88; antimony, 12.

"Phosphor bronze: Copper, 90 to 92; phosphide of tin, 10 to 8.

"Tobin bronze: Copper, 59 to 61; tin, 1 to 2; zinc, 37 to 38; iron, .1 to .2; antimony, .3 to .35.

"You probably will never be called upon to mix any of

these compositions yourselves, and it is well that you will not, as it takes an expert to do it. However, it will do you no harm to know what goes into the various metals with which you will have to deal.

"There is another alloy which is rapidly coming in use for marine machinery, known as 'Monel metal.' Unlike other compositions, it is mixed by Nature itself, as it is in reality nickel ore just as it is mined. It is composed principally of nickel and copper in about the proportion of 65 to 35. It has been found to be very efficient for valve seats in steam valves where superheated steam is used, for pump rods and valve stems, and for propellers. The tensile strength is equal to that of steel, and it is non-corrosive in salt water and acids.

"I have now described to you in a general way the principal materials used in an engine room——"

"You have left the main ones out, Chief!" said O'Rourke.

"What are they?"

"Why, the gold and silver that are handed out once a month."

"You'll have to know a good deal more about steel and brass than you do now before you can connect very strongly with those metals," retorted McAndrew, as he dismissed the class for the evening.

(To be continued.)

Economy of Inclined Dock Elevator

The recent activity of the transportation companies and traffic organizations in general, in studying and analyzing the costs and methods of freight movement, has revealed some interesting facts and figures which show the economies and increased efficiency that can be effected by proper equipment at the terminal station.

Many of the largest transportation companies have found the inclined dock elevator a most useful and practicable device for the movement of freight to and from vessels and the pier. As a result of their observations and studies, certain convincing figures are available which show clearly the savings in time, labor and money that the dock elevator makes possible.

The inclined dock elevator, which is built by the Otis Elevator Company, New York, is extremely simple in construction and operation, so that it can be installed on almost any gangway. It consists of an endless chain with projecting teeth or lugs, which travels in a steel channel over sprockets on each end. Where it is necessary to meet a variation in the height of vessels due to the rise and fall of the tide, a set of hinges of special design are furnished upon which the "inclined drop" may be raised or lowered. Through suitable spur gear drive a motor operates the dock elevator at speeds varying from 125 to 250 feet per minute. These speeds may be varied by an attendant through the use of a controller operated by hand. The truckmen bring their hand trucks or electric trucks to the inclined elevator, the lug of the moving chain engages the axle of the truck and the truck is carried on its wheels up or down the incline. The truckmen are relieved of the tiring strains at the incline and the movement of the trucks is accomplished rapidly and easily.

The current consumption is relatively small. When the dock elevator is running without loads on a steep incline, say at an angle of 25 degrees from the horizontal, to operate the machine requires but one horsepower. Suppose the dock elevator is loaded to carry 2,500 pounds of freight continuously for one hour up an incline 50 feet long, erected at an angle of 25 degrees, the chain moving at a rate of 250 feet per minute. To have a constant load of 2,500 pounds on the dock elevator at this rate, it will be reloaded every twelve seconds. In a minute, consequently, the dock elevator will carry up 12,500 pounds, or in an hour 750,000 pounds of freight.

The costs for power, under these conditions, at current cost of 5 cents (2½d.) per kilowatt hour, approximates 42½ cents (1s. 9¼d.) per hour. In other words, 375 tons of freight can be moved in an hour at a power cost of 42½ cents (1s. 9¼d). This case is cited to show the enormous freight handling ability of the dock elevator. Under ordinary circumstances it is not called upon to operate at full capacity, due to the fact that the trucks cannot be brought rapidly enough to the elevator.

The capacity varies, of course, according to the speed at which it is driven, the type of truck employed, and the speed at which the truckmen move their trucks. Ordinary hand trucks can be carried about ten feet apart. At a speed of 250 feet per minute, the machine is capable of transporting 1,500 hand trucks per hour. Running at a decreased capacity, the power costs are proportionately smaller. Now when it is remembered that from actual experiences fully 25 percent of the number of truckmen required under old-fashioned

INCLINED DOCK ELEVATOR, HAULING AN ELECTRIC TRUCK AT MERCHANTS' AND MINERS' DOCK, SAVANNAH, GA.

methods can be dispensed with, and that the remaining stevedores can individually perform the work of several men working under old-time methods, the savings in wages and time and the increased freight-handling capacity make the costs for power very small indeed.

Mr. Albert Smith, general agent of the Metropolitan Steamship Company in Boston, Mass., has stated that the three inclined dock elevators which are operating on the Union Wharf not only have been the means of considerable saving in the cost of handling the cargo, but that it would take at least 25 percent more time to discharge the steamers without the dock elevator.

A very desirable effect is produced by this apparatus on the truckmen. Because of the rapid movement of the inclined elevator and the ease in ascending the incline, the truckman ascends at a trot. When the top is reached he must not slacken, because of the line of trucks behind him. This has a tendency to speed up all the workers and keep them moving at a dog trot on the levels as well as on the incline.

As mentioned before, the dock elevator is so built that the variations in tide cannot affect the usefulness of the machine. The vessels can be loaded and unloaded at ebb or flood tide with almost the same dispatch and ease. In some instances where the rise and ebb of the tide is very pronounced, the dock elevator has performed its work at a grade approximately 45 percent.

The Possibilities of the Marine Oil Engine

BY THEODORE LUCAS

In the rapidly extending development of new or at least, novel methods of power application to propulsion of ships, the possibilities of the internal combustion engine deserve an earnest and painstaking study.

The principal advantages of this type of engine may be summed up as:

(1) Small space, most pronounced with oil-burning engines.

(2) Light weight or possibility of further saving of weight.

(3) Rapidity in passing from no power to full power and vice versa.

(4) Absence of hot steam pipes.

(5) Absence of boilers which, by explosion, may endanger life of men and safety of ships.

The principal disadvantages of the type may be classified at the present stage of perfection as

(1) Employment of light volatile oils, like gasoline (petrol) or benzine as fuels, with the attending high cost and danger of explosion.

(2) Lack of reversibility in the propelling engine and lack of an always available power impulse for ready and handy stopping and starting.

(3) Lack of a handy, directly available power medium for operation of all the various auxiliaries on board of a large ship from one central source.

(4) Lack of a handy medium for heating and cooking in the living spaces similar to steam radiators or steam hot tables.

All these disadvantages are avoided by steam machinery, and the internal combustion engine will have to overcome them if it shall be able to fully compete with steam machinery. But if it is possible to solve these questions with satisfaction, then the internal combustion engine will supersede steam machinery, reciprocating as well as turbine. It may be of interest to indicate the way by which such improvement of the internal combustion engine may possibly, and even probably, be secured.

Among the fuels available for use in internal combustion engines, gasoline (petrol) and naphtha are the most convenient ones, as they can be evaporated without any residuum, and in this vaporized form can be mixed with the air needed for its clean and complete combustion. But every power user knows that the heavy oils, the kerosene (paraffin), and yet heavier products of petroleum distillation, and even the crude oil itself, have greater heat and power capacity per pound, while being much cheaper in price as well as much safer in handling and storing, than gasoline (petrol). The qualities of safety are due to the fact that the heavy oils are less volatile than gasoline (petrol). But this lack of readiness of evaporation, while excellent for safe storing, is not as convenient for getting the oil into the engine in such form as will allow a ready mixture with air and a clean and complete combustion.

The fact of there being two methods of fuel combustion in internal combustion engines is often lost sight of. These methods are:

(1) Explosive method.

(2) Combustion method.

The first one is used by engines frequently called the constant volume type, while the second one is used by those called the constant-pressure type.

The first, which is the best-known one, is used in all, or nearly all, classes, and makes of gasoline (petrol), light oil, or gas engines. The fuel charge is generally evaporated by and mixed with the ingoing admission air and forms with it an explosive mixture, which, after suitable compression, is ignited by an electric spark.

This method has also been tried for heavy oils, but with much less success, as these fuels cannot be readily evaporated by an air current, but need application of heat, which is apt to dissociate them and throw down tar or carbon, that will foul and eventually clog the engine.

Fortunately the combustion method can deal very successfully with the heavy oils. The principle upon which engines can be operated by this method is to provide in the cylinder sufficient heat for immediate ignition and complete combustion of the heavy oil, and only inject the heavy oil in small quantities just when it is needed. Of these oil injection engines two subdivisions may be distinguished:

(1) Hot chamber or shield vaporizing type.

(2) Mechanically atomizing type.

The former has for its purpose heat application so graduated as to just vaporize the fuel for ready mixture with the compression charge of air. The latter has for its purpose a purely mechanical spray or atomizing action upon the fuel, to break it up into the minutest globules and to surround it so closely by highly compressed and thereby heated air that a rapid combustion takes place. Of these subdivisions of the combustive method the latter, atomizing type, is the most promising, and of it the most efficient and best-known representative is the Diesel engine. While not yet largely introduced in marine practice, it is gaining ground steadily, and is making a remarkable showing in stationary practice, due to an unparalleled economy—about 50 percent better than the best gas or gasoline (petrol) engines of the explosive method. This is done with the cheapest grades of crude or fuel oil, such as can be bought nearly everywhere for 2 to 5 cents (1 to 2½d.) per gallon. It compares, therefore, in fuel costs, very favorably with a gasoline (petrol) engine. The possibility is that engines operated on the combustive method of fuel consumption are the coming type for marine propulsion, as they can operate with fuels that can be obtained cheaply and in large quantities in all the principal ports of the Atlantic and Pacific coasts of North America. The experience on the Pacific Coast, where heavy oils are now extensively used as fuel under steam boilers, has proved conclusively that these oils can be safely handled and stored upon commercial ships of all sizes. They avoid, therefore, the severe insurance and supervision restrictions that the underwriters and government inspectors place upon the storing of light oils, like gasoline (petrol).

The Diesel engine draws in only pure air, which it compresses to a pressure of about 525 pounds per square inch, and thereby imparts a great deal of heat to the compressed air; in fact, it gives the air charged so high a temperature that the crude oil, or fuel oil, when gradually sprayed into this red-hot compressed air, begins to burn immediately without any special ignition apparatus. It will be seen that a pronounced simplification of the machinery takes place in this absence of any ignition apparatus. This simplification is highly desirable, as in the generally damp and salty atmosphere of marine surroundings the ignition apparatus has always proved a source of great annoyance and unreliability. It has been found that the spraying of the oil charged into the cylinder at the commencement of the combustion stroke against the high pressure of 525 pounds of compression is best done by compressed air of about 800 to 1,000 pounds pressure per square inch. This breaks up the oil into very small globules mixed already with air and ready for an immediate ignition and combustion. This, of course, involves the installation of a high-pressure air compressor for the continuous supply of the needed injection air which might appear as a complication and burdensome

addition to the power plant. The history of the marine steam engine proves, however, that the addition of auxiliaries tends to enhance economy and handiness, even if involving an increased first cost and labor of attendance. The addition of an air compressor to an internal combustion engine for marine propulsion can be considered only as an advantage because compressed air, stored in suitable receptacles, can furnish also the medium for readily reversing the main engine as well as for operating all the auxiliaries that are now in use on board of any vessel. The Diesel engine, of the modern stationary type, employs most successfully its injection air supply for the starting of large units in which cranking by hand would, of course, be entirely out of question.

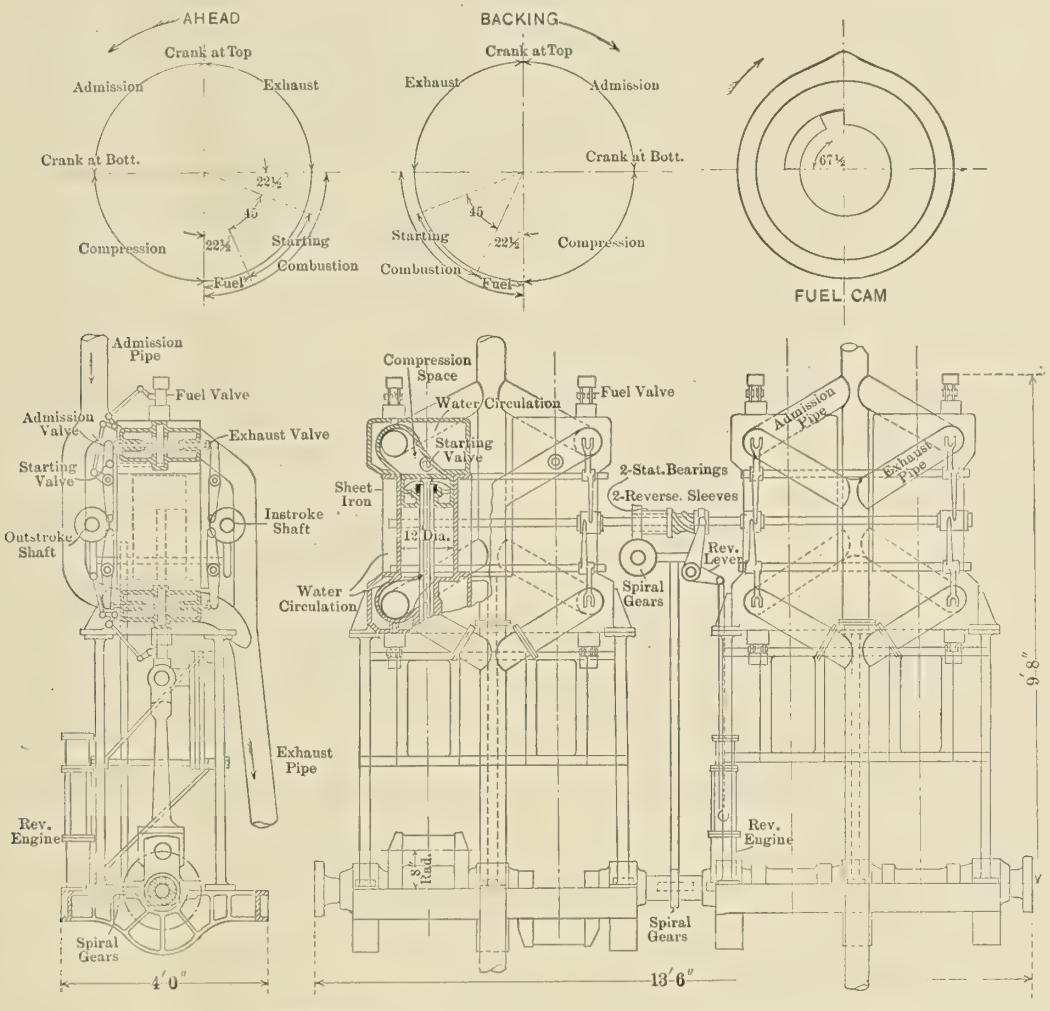


FIG. 1.—DESIGN OF A FOUR-CYLINDER, FOUR-CYCLE MARINE DIESEL ENGINE

Reversibility of the high order of the modern marine steam engine is dependent upon two factors:

(1) An automatic valve-gear that, upon simple operation of a hand lever, will make the direct-connected engine go immediately and continuously in the desired direction.

(2) A power impulse which, under the direction of the automatic valve-gear, can start the engine from any position into the desired direction of rotation immediately and without any other outside source of power.

In the internal combustion engine, as at present employed for marine service, very few builders have attempted to fulfill the two above-mentioned conditions. Most of them have been satisfied to solve the problem of reversibility by installing an engine that is kept continuously rotating in one direction and by connecting the engine to the propeller shaft by a mechanical reversible clutch with exchangeable, toothed or friction gearing. Another method is to connect the engine capable of rotating in one direction only with a propeller that is fitted with feathering blades. Both of these methods are suitable only for small boats and powers. Still another method which has been tried in Europe in a few cases is the connection of one or more Diesel engines of the stationary type rotating in one direction only to one or more dynamos and transmitting the electric current by way of the navigating bridge to reversible electric motors on one or more independent short propeller-shafts, fitted with ordinary propellers, but as can readily be imagined, the cost and weight of this electric transmission plan are high, and this fact will probably deter most owners of ships from installing it. A modification of this electric transmission system connects the Diesel engine to the propeller in such a manner as will enable direct drive for ahead motion, but uses a comparatively small dynamo at the engine going ahead to drive an electric motor upon the disconnected propeller shaft for backing motion.

The solution of the question of reversibility lies doubtlessly in the same direction in which the modern marine steam engine has made so great a success. This means for the internal combustion engine suitable for all classes of ships as a propelling agent an automatic reversible valve gear and an always ready and available impulse medium for which compressed air seems to be the most suitable. Regarding the first factor of reversibility, it has often been contended that the four-cycle internal combustion engine, of which the valve shaft runs at only one-half the number of revolutions of the crankshaft, cannot be fitted with automatic reversing gear. This opinion is erroneous, but a variation has to be introduced by making the reversing arc of the cams only 90 degrees. An addi-

tional complication is that some of the valve-gear members have to be advanced 90 degrees, while others have to be turned back 90 degrees to secure such conditions as will automatically and continuously rotate the engine in the new direction. These difficulties, however, can, by thorough study and analysis, be satisfactorily overcome in more than one way.

Fig. 1 shows a four-cylinder, four-cycle marine engine of the Diesel type, operated by revolving cam-shafts, cams and poppet valves, as usually fitted to internal combustion engines. In this case the valve members have been divided into two groups of

(1) Instroke members, comprising all the exhaust valves.

(2) Outstroke members, comprising all admission, fuel and starting valves.

As all members of the same group move for reversing in the same direction it seemed best for practical construction purposes to give one strong shaft to each group and reversing all cams with the shaft. It is thus possible to fit for each shaft a powerful reversing sleeve of the type frequently employed in high-powered yacht engines. These sleeves can be conveniently operated by a reversing engine, as shown in Fig. 1, which may be operated by compressed air and fitted with an oil cylinder, to prevent dancing and vibrating of the valve gear.

The diagrams of Fig. 1 show how the different cams have to be set and how they have to move with their respective shafts to secure an automatic and prompt reversal. As the fuel cam has to move through an arc of only 22½ degrees its cam may be fitted as shown, sliding on its shaft in the manner of the loose eccentrics used in the old-style paddle-wheel engines. By making the boss and the feather long no difficulty of excessive wear need result from this construction.

Other four-cycle engine arrangements without sleeve reversing and cams, necessarily heavy for large engines, may solve the problem by providing, instead of revolving cams, swinging levers in a manner similar to our familiar beam engines. These levers may be operated from a regular link-gear with the usual marine reversing engine, rock shaft and adjustable rock-shaft levers, by which the fuel valve cut-off can be regulated while running. For two-cycle engines the special valve shafts are avoided and a regular link-gear can be fitted directly to the crank-shaft. One form convenient for two-cycle oil engines of the Diesel type employs a Pius Fink link which, in simple arrangement, needs only one eccentric, and is well adapted to the large angular advance and the short cut-off of the fuel valve, never exceeding 10 percent.

Fig. 2 illustrates a two-cycle double-acting engine, in which a Marshall type reversible valve gear is employed to work scavenging air-admission, fuel injection and starting valves. The two latter are so connected that the one is out of action when the other is working. A further improvement shown in Fig. 2 is positive control of all poppet valves without springs, thereby avoiding looseness, noise and motion in a seaway. The whole engine will be found resembling quite strongly the normal marine steam engine.

The second point of efficient reversibility is a ready power impulse that can start the engine from any possible position immediately and powerfully in the new direction of rotation. This should take place in the same manner as live steam from the boiler starts the marine steam engine, upon opening of the throttle. The power impulse should be powerful enough to overcome all frictional resistances of the engine and of the shafting with propeller, as well as of compression-pressures in the engine. With six or four cylinders there can always be one cylinder receiving starting air with its crank under a favorable starting angle, so that the engine will readily start from any position. Great economy is needed with the starting air, as it takes considerable power to provide compressed air of high pressure and the cylinders with their large volumes are powerful consumers of the air.

The opening of the starting valves must be automatic with the operation and running of the engine, while being at the same time under the control of the engineer for their immediate throwing in or cutting out. The style of floating lever, as employed for the automatic operation of the reversing engine, is well adapted to perform the operation of the starting valve with automatic and manual control. The same hand-

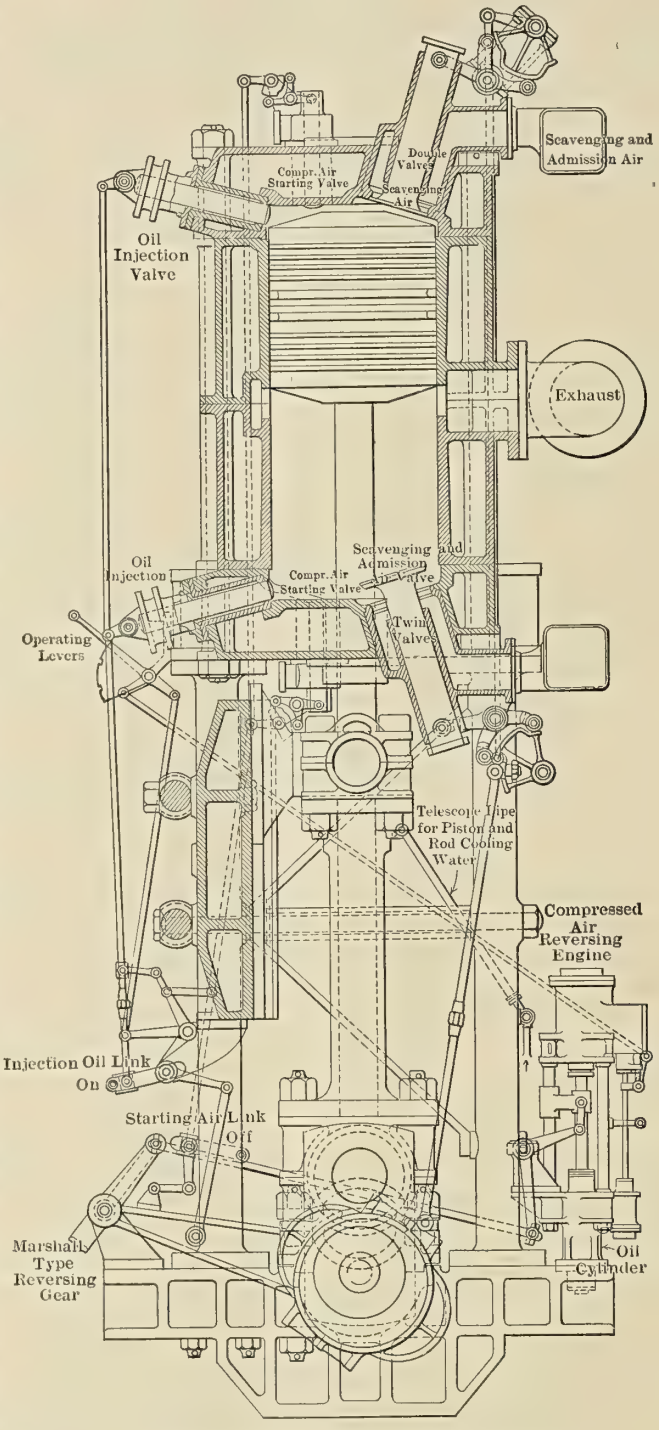


FIG. 2.—TWO-CYCLE, DOUBLE-ACTING OIL ENGINE

lever that the engineer employs for control of starting valves can in its opposite swing be employed for opening and shutting of oil valves which may be used to regulate the admission of the oil into the fuel valves. The engine of Fig. 2 shows an arrangement in which the same hand-lever actuates the connecting rods of the starting valves, as well as of the fuel valves, the one being completely shut off when the other one is on. With such arrangements an internal combustion engine

of the Diesel type may be considered equal to a steam engine, as far as handiness and reversibility are concerned.

The question of increased or reduced powers will yet have to be considered. An internal combustion engine of any type is inferior to a steam engine as regards overload. A steam engine can always be urged to a little larger exertion by increased pressure or later cut-off, while an internal combustion engine cannot consume any fuel in excess of that which can be burned by the available oxygen of the admission charge. But an oil engine of the Diesel type is superior to a steam engine as far as reduced power goes, because it keeps its economy much better at low powers than is possible for a steam engine. The reducing of the power is done at the fuel pumps that supply the oil in liquid state to the fuel valves. By keeping the bypass or suction valves open during a longer or shorter part of the stroke of the fuel pump plungers a larger or smaller amount of oil in very accurate regulation is delivered to the valve. The usual eccentric mechanism that acts upon the valves is, in stationary installations, operated by the governor, while in marine installations a special hand-lever can be arranged at the engineer's platform. An engineer operating such a Diesel marine oil engine would have at his platform almost exactly the same working levers as a steam engineer has. He would have an air and oil lever corresponding to the steam throttle valve lever, also a reversing engine lever in the same form as the engineer of a steam engine has, and lastly an oil pump regulating lever corresponding to the engine-room stop-valve wheel for the purpose of running the engine under reduced powers. For large engines, as illustrated by Fig. 2, additional levers and gear could be provided at the engineer's platform for a ready control of butterfly valves in the ducts leading from the scavenger blowers. Control may also be had of valves in the admission pipes, from the cooling water pumps to the cylinders, cylinder covers, pistons and piston rods, until all the overflows show steady stream and uniform temperature.

The crude oil does not offer a very convenient and clean medium for power distribution to all kinds of auxiliaries, and this drawback necessitates for most cases the fitting of a sort of central station in connection with the main engines. Small oil engines of highly economical type could there be employed to transfer their energy to either electricity or compressed air or perhaps to a combination of these two agents. As it is necessary to have compressed air for oil injection and for starting purposes it seemingly offers a convenient way of operating all auxiliaries.

As is well known, compressed air can be used exactly like steam in all small rotating engines now used on board ships, as well as in all reciprocating, direct-acting pumps. By employing compressed air from a central power station the same auxiliary engines or auxiliaries which the steam engineer or oiler is in the habit of operating now may be used, perhaps retaining in a change of motive power for an old ship all the same auxiliaries, but without the disadvantages of heat and dripping condensed water and with the advantage of a fine, cold air ventilation. Compressed air may also prove of advantage on board ship by its application to calking, chipping and boring tools for wood and iron in repairs and alterations as frequently required on board of large passenger or cargo vessels.

To get maximum economy and convenience out of the low-pressure air transmission to the auxiliaries, reheating of the air may readily be obtained, either in special oil heaters or by the hot exhaust gases from the compressor engines. This would do away with freezing at the small engines, while greatly increasing the economy of the power transmission. The application of compressed air to auxiliaries from a central source is the more profitable, the larger the ship and the larger the whole machinery plant.

A machinery plant with Diesel oil engines is pre-eminently fitted for large vessels of commercial as well as naval service. In such vessels one might apply the compressed air to driving the reversing engine, the turning engine, all the cooling water pumps of the main propelling engine and of the air-compressor. Further, there can be driven the fire pumps, the bilge pumps, the water bottom pumps and the sanitary hot, cold, fresh or salt water pumps. Then there can be driven the dynamos, the ice machine, the steeering engine, the winches, the windlass, and, for naval vessels, the ammunition hoists and turret-turning gears. It can readily serve in purely reciprocating apparatus such as pumps, hoists, lifts, as well as in crank movement apparatus like winches, windlass, steering engine, etc. An advantage is also that its control may be local or from a distance, like locations in the pilot house, controlling a steering engine, or on a gunsighting platform in a turret controlling the turning or ammunition hoist-engines.

In the light of the development of the steam turbine of the last few years, a compressed-air turbine of good economy, perhaps multistage, might prove quite feasible and practical for driving purely rotating apparatus like fans, high- and low-pressure centrifugal pumps, dynamos, electrical boosters or rotary transformers, if such might be required.

An advantage of the compressed air is that its engines can be arranged without any discomfort under protective decks and in armored spaces with little ventilation. The ventilation of many spaces can conveniently be arranged by compressed air without special engines or fans. The use of compressed air for auxiliaries contributes most materially to the habitability of the ship and the comfort of the crew. By using the high-pressure only for oil injection in close proximity to the last stage of the compressors very little piping need be exposed to the high pressure.

For operating the auxiliaries, it would not be advisable to employ the air at 800 to 1,000 pounds pressure, as required for injection purposes; but, as the injection air has to be obtained in multistage compression, it is well, possibly, to provide tanks for storing air at an intermediate stage, say 125 to 150 pounds, and use this air for starting at relatively late cut-offs, as well as for operating auxiliaries. By making the first two cylinders of the air-compressors extra large the extra supply of medium-pressure air for the auxiliaries can readily be obtained without further complication and stored in special medium-pressure receivers of relatively large capacity. These resemble in their power-storing capacity the boilers of the steam installation, as being always ready for service in starting main engines and in operating auxiliaries, and with considerable less attention than boilers require. Electricity will probably always be demanded for lighting purposes and wherever else it would seem to offer special advantages. In the central power station the driving engines for generator sets would be similar to the main engines, except being single-acting of the stationary, governor-controlled type. As found with steam auxiliaries on board ship subdivision into interchangeable units proves handiest. In this light, it might seem best to arrange for several multistage air compressors with extra large low-pressure cylinders and directly connected to double cylinder oil engines. As the whole operation of the main engines and auxiliaries depends upon the presence of available compressed air, several interchangeable compressor units, each nearly powerful enough for maximum requirements, would seem the safest outfit to adopt.

The tremendous improvement in fuel economy of oil engines of the highest type, the great saving in space and in weight and the consequent increase in earning capacity of the ship over a corresponding steam engine of reciprocating or even turbine type, is bound to be recognized by the marine world before long.

In the United States, where there is an abundant fuel supply, the situation is especially favorable to the installation of oil engines.

Recent Developments in Oil Fuel Burning*

BY E. H. PEABODY

IDALIA EXPERIMENTS

Having completed preliminary experiments with the atomizers in connection with a fire-brick oven built for the purpose and entirely separate from a boiler, the apparatus was removed to the Babcock & Wilcox Company's dock at Bayonne, N. J., where the steam yacht *Idalia* was moored preparatory to being laid up for the season. This vessel is fitted with a Babcock & Wilcox marine boiler containing 2,560 square feet of heating surface and 340 square feet of superheating surface. A simple and effective system of induced draft fans is installed capable of giving a suction in the uptake of 1 to 1¼ inches of water, and in addition to this a forced draft fan was set up on the dock and connected by means of a flexible duct to a sheet steel casing enclosing the oil burners on the front of the boiler. The tanks and scales for weighing the oil and water, and the oil pump and heater, were set up on the dock and connected with the vessel by means of flexible pipes, the regular feed pump of the plant being used taking weighed water from the filter box. The engine and other auxiliaries were not in use, the steam being discharged to the atmosphere through a muffler so arranged, however, as to maintain regular working pressures on the boiler. All precautions were taken to prevent leaks and secure accurate data.

The object of these tests was to burn oil with mechanical atomizers, to burn as much oil as possible without smoke, and to secure the best possible evaporation per pound of oil.

Fifteen evaporative tests were made under a variety of conditions. In between these tests considerable experimenting was done with various air-distributing arrangements, flat-flame burners, etc. The best performance was an evaporation of 7.47 pounds of water per square foot of heating surface per hour from and at 212 degrees at an efficiency of 82.8 per-

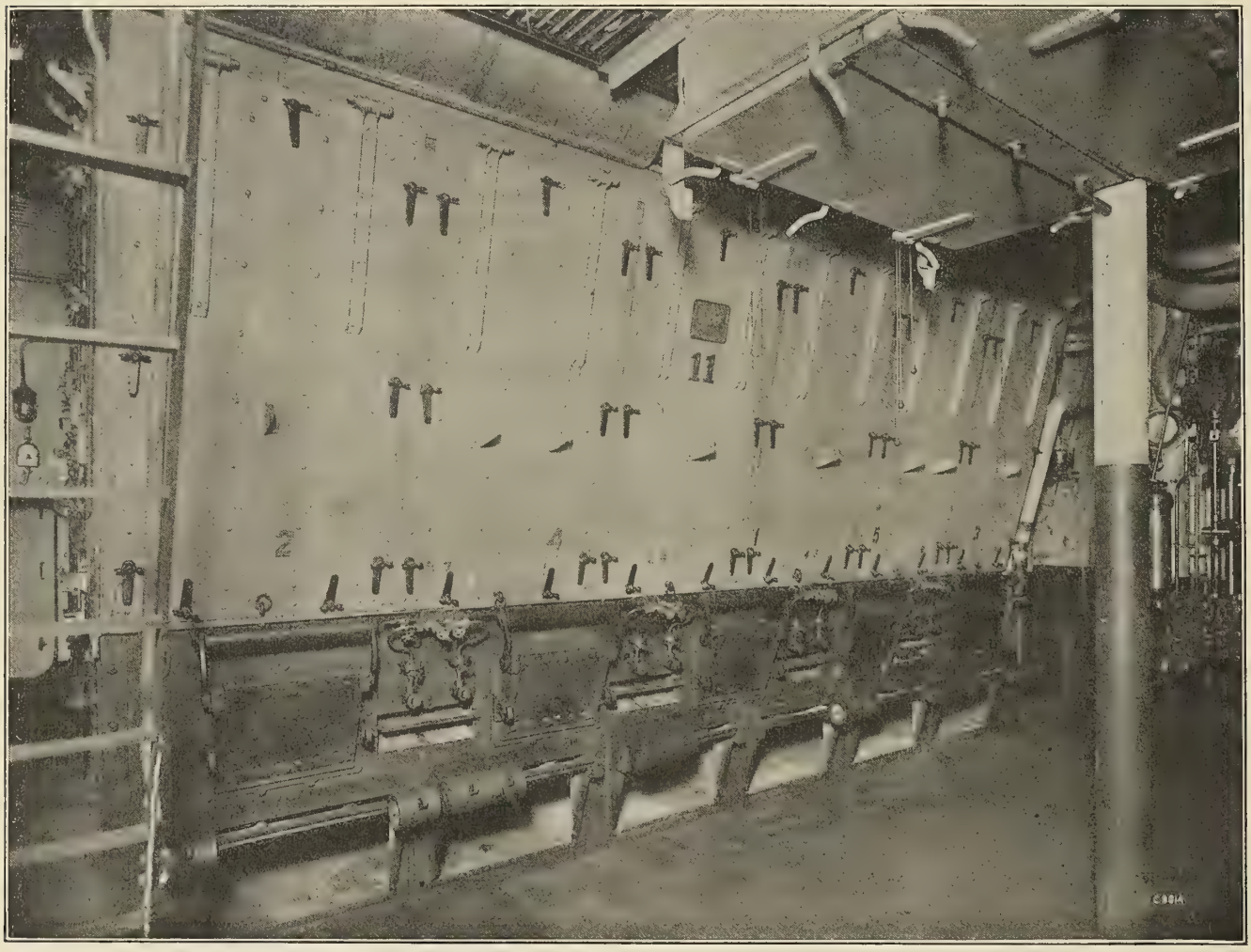


FIG. 11.—BABCOCK & WILCOX BOILER, U. S. S. WYOMING, SHOWING OIL BURNERS IN COMBINATION WITH COAL

cent at a rate of combustion of 6.17 pounds of oil per cubic foot of furnace volume per hour, with a draft in the uptake of .84 inch of water. The air in this test was admitted to the furnace through what we call an impeller plate, Fig. 12. Beginning with the cast iron cone with air slots on the side as shown in Fig. 10, various other air distributors were tried, but none of these seemed to promise as well as the impeller, either as to smokelessness, gas analysis, ignition of the oil, or noise.

WYOMING TESTS

Coal.—The contracts for the United States battleships *Wyoming* and *Arkansas* called for a series of four 24-hour guarantee tests with coal, the first to be at a rate of combustion of 15 pounds, the second at 25 pounds, the third at 35 pounds, and the last at 40 pounds of coal per square foot of

* Continued from the January issue.

grate surface per hour. The idea was to duplicate a possible severe war condition, and it was required that the evaporation per pound of combustible in the final test should not be less than 11 pounds of water from and at 212 degrees. This requirement was increased to 11½ pounds for the next contract after obtaining the excellent results in the tests on the *Wyoming* boiler.

As both the U. S. S. *Wyoming* and the U. S. S. *Arkansas* were fitted with Babcock & Wilcox boilers, and as both these ships were to burn oil in combination with coal, it was decided to build a special test boiler of exactly the same design and proportions, except that it was not as wide, set this up at the works, with an air-tight house around it, force air into this house under pressure to duplicate the conditions of a closed fire room on board ship, and after making the guarantee tests with coal continue the experiments with oil, and with oil and coal in combination. This plan proving acceptable to the Engineer-in-Chief of the Navy, the boiler was built and tested under guarantee conditions by a board of naval officers, of which Captain C. W. Dyson was the senior member.

As this same boiler was later tested with oil fuel, the comparison with coal is of general interest, and I have therefore copied the results of the coal tests from the Board's reports (Table I). It will be noticed that a fifth test was made at the high rate of combustion of practically 70 pounds of coal per square foot of grate per hour. This was not part of the guarantee, but was made at the request of the builders to show the possibilities of forcing the boiler. In this test, 14.76 pounds of water were evaporated from and at 212 degrees per hour per square foot of heating surface.

Preliminary Tests with Oil Fuel.—After the completion of the coal tests the boiler was thoroughly cleaned of soot and ashes, fire-bricks were laid on the grate bars, and the front was arranged to receive the oil burners and air-distributing device.

While the results of the *Idalia* experiments had been promising it was desired to materially increase the capacity, .45 pound of oil per square foot of heating surface and about 6.2 pounds per cubic foot of furnace volume having been the maximum in those tests. In this we were assisted by the fact of having available a strong closed fire-room draft and a powerful steam jet in the stack. Much experimenting was, however, found necessary, almost entirely in the direction of air admission and distribution, some two months being devoted to preliminary trials of various forms of apparatus.

TABLE I.—WYOMING. OFFICIAL TESTS WITH COAL

Babcock & Wilcox boiler, 2,571 square feeet H. S., G. S. 57.3; ratio, 44.4 to 1; Pocahontas, hand-picked coal

Date of test, 1910.	June 13–14.	June 14–15.	June 15–16.	June 16–17.	June 18.
Duration of test (hrs.)	24.06	24.5	24.0	24.0	3.0
Steam pressure (lbs.)	202	201.4	202.8	201.6	200.4
Temperature feed water (°F.)	211.6	211.4	207.8	204.1	194.4
Moisture in steam (p. ct.)	0	0	.086	.172	.43
Moisture in coal (p. ct.)	.88	.74	.74	1.06	.75
Dry coal burned per hour (lbs.)	873	1,425	2,039	2,379	4,036
Per cent refuse in dry coal by test	6.0	3.83	3.28	4.34	8.55
Dry coal burned per square foot of grate per hour	15.08	24.62	35.22	41.10	69.72
Draft in uptake (in.)	−.31	−.94	− .30	− .26	—
Draft in furnace (in.)	−.16	−.46	+ .66	+ .91	—
Air pressure in fire-room (in.)	.00	.00	+1.41	+1.95	+3.00
Temperature air entering ash pit (°F)	94	98	86	94	106
Temperature waste gases (°F.)	491	545	602	628	659
Analysis of waste gases (p. ct.) CO_2	13.2	13.6	12.9	13.6	116
Analysis of waste gases (p. ct.) CO	4.2	4.7	4.5	3.9	5.07
Analysis of waste gases (p. ct.) O	0.5	0.4	0.5	0.8	1.09
Analysis of waste gases (p. ct.) N	82.1	81.3	82.1	81.7	82.24
Water evaporation into dry steam per hour from and at 212° (lbs.)	9,974	16.543	23,208	27,060	37,951
Water per square foot heating surface per hour from and at 212° (lbs.)	3.88	6.43	9.03	10.52	14.76
Water per pound dry coal from and at 212° (lbs.)	11.42	11.61	11.38	11.38	9.45
Water per pound combustion from and at 212° (lbs.)	12.15	12.07	11.77	11.89	10.33
Efficiency based on dry coal (p. ct.)	72.50	73.70	72.24	72.24	60.00
Heat balance in per cent, calorific value of combustible—					
Absorbed by boiler (p. ct.)	74.39	73.95	72.06	72.80	63.25
Loss due to heat in waste gases (p. ct.)	11.09	12.24	14.63	14.20	16.31
Loss due to moisture in fuel (p. ct.)	.07	.06	.06	.09	.07
Loss due to burning hydrogen (p. ct.)	3.27	3.34	3.44	3.45	3.46
Loss due to incomplete combustion (p. ct.)	2.09	1.61	2.15	3.18	4.98
Various other losses including radiation and unaccounted for (p. ct.)	9.08	8.80	7.66	6.28	11.93

Again the flat-bladed impeller plate was found to be most suitable, a number of different designs of this being tried out, among which may be mentioned one having adjustable blades. Finally, with the grate bars in place, six burners and impellers were installed, two in each fire door, and a test was made resulting in a combustion of .72 pound of oil per square foot of heating surface and 11.6 pounds per cubic foot of furnace volume, a very distinct advance over the *Idalia* performance.

The grate bars were then removed, the ash pan lined with fire brick, a second row of burners installed below the first, and efforts to obtain still higher capacities were continued. The experiments indicated that a considerable number of smaller burners and impeller plates was preferable to a few of larger size, and the furnace front was remodeled and fitted with eleven cast iron boxes 13 inches square, each carrying an impeller plate 8 inches in diameter and each arranged to receive a burner. With nine of these burners in operation an evaporization of 13.16 pounds of water per hour from and at 212 degrees per square foot of heating surface was obtained, burning .85 pound of oil per square foot.

The figures thus obtained seemed to warrant our requesting that a board of naval officers be appointed to witness and supervise further tests. There was no guarantee connected with the matter, but we were desirous of demonstrating to the Navy Department what could be done with our apparatus, and also particularly to have the results checked by competent and thoroughly disinterested observers who should secure sufficient authentic data to place the final figures absolutely above criticism. It seems unfortunate that this plan is not more frequently followed, as *ex parte* tests are always open to doubt, especially when the results are unusual.

Official Tests with Oil Fuel.—The following extract is from the beginning of the Board's report:

"This test was conducted by a Board composed of Captain C. A. Carr, U. S. N., and Lieutenant-Commanders J. K. Robinson and John Halligan, Jr., U. S. N.

"The Board assembled at the works of the Babcock & Wilcox Company, Bayonne, N. J., about 10 A. M., Nov. 28, 1910. The Board examined the test boiler and its connections for water and steam tightness, the arrangements for measuring water and oil and the apparatus for taking data. All of these were found satisfactory, and the tests were proceeded with at once. In all these tests oil was used as a fuel.

"Civilian assistants from the office of the Inspector of Machinery, Bayonne, N. J., were detailed for the purpose of tak-

TABLE II.—WYOMING. OFFICIAL TESTS WITH OIL

Babcock & Wilcox boiler, 2,571 square feet heating surface; Peabody mechanical atomizers; Texas oil—lighter constituents removed

Date of test, 1910.	Nov. 28.	Nov. 28.	Nov. 29.	Nov. 29.	Nov. 30.	Dec. 3.
Duration of test (hrs.)	2	3	3	4	3	3
Steam pressure (lbs.)	210	210	211	212	215	215
Temperature of feed water (°F.)	168.6	160.9	201	211.2	185.6	182.8
Moisture in steam (p. ct.)	.81	.71	.16	.11	.22	.17
Pressure of oil at burners (lbs.)	191	189	176	131	153	172
Temperature of oil at burners (°F.)	175	183	184	210	199	196
Oil burned per hour (lbs.)	2,972	1,704	1,202	666	1,922	1,947
Oil burned per burner per hour (lbs.)	270.2	213	300.5	222	240.3	243.4
Oil burned per cubic foot furnace volume per hour (lbs.)	13.69	7.85	5.54	3.07	8.86	8.97
Oil burned per square foot heating surface per hour (lbs.)	1.156	.663	.467	.259	.747	.757
Draft in uptake—referred to atmosphere (in.)	−2.23	−.41	−.46	−.39	− .61	−1.15
Draft in furnace—referred to atmosphere (in.)	—	—	—	−.32	+ .32	− 0.01
Air pressure in fire-room—referred to atmosphere (in.)	+2.60	+1.69	+1.18	+.33	+1.97	+1.64
Temperature of air in fire-room (°F.)	71	75	70	79	79	76
Temperature of waste gases (°F.)	771	666	533	447	702	630
Analysis of waste gases (p. ct.) CO_2	9.85	9.26	11.57	11.86	10.71	10.94
Analysis of waste gases (p. ct.) O	6.46	7.68	4.50	4.08	5.18	4.73
Analysis of waste gases (p. ct.) CO	.01	.00	.04	.04	.02	.00
Analysis of waste gases (p. ct.) N	83.68	83.06	83.89	84.02	84.09	84.37
Water evaporated per hour from and at 212° (lbs.)	40,712	24,494	18,895	10,569	27,149	30,064
Water evaporated per square foot heating surface per hour from and at 212° (lbs.)	15.83	9.53	7.35	4.11	10.56	11.69
Water evaporated per pound of oil from and at 212° (lbs.)	13.70	14.37	15.72	15.86	14.12	15.44
Specific gravity of oil	.932	.932	.932	.932	.932	.932
Flash point of oil (°F.)	295	295	295	295	295	295
British thermal units per pound of oil	19,291	19,291	19,291	19,291	19,086	19,086
Efficiency (p. ct.)	69.29	72.68	79.50	80.21	71.41	78.08
Number of burners in operation	11	8	4	3	8	8
Smoke on scale of 5	2.1	1.5	1.3	1.5	2.3	1.15

ing data. Another set of observers was furnished by the Babcock & Wilcox Company, who took data independently. The data taken by the two sets of observers were compared, so that any errors in reading were corrected at once."

The report concludes as follows:

"The Board was particularly impressed with the excellent

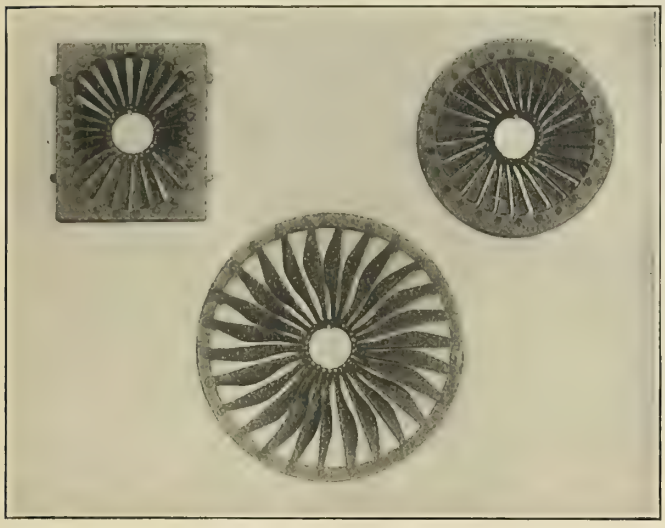


FIG. 12.—IMPELLER PLATES

results obtained with this boiler under the maximum rate of combustion, Test No. 1, which gives a combustion of 13.69 pounds of oil per cubic foot of furnace volume. This is the equivalent of about 75.34 pounds of coal per square foot of grate area in the same boiler when burning coal. The boiler in this test steamed freely with a very slight increase in the wetness of steam, and the falling off of efficiency was small for a rate of combustion much above the maximum ordinarily used on boilers of the Navy under forced-draft conditions.

"After all the tests were completed the boiler was opened, cleaned and thoroughly inspected for deterioration. No tubes

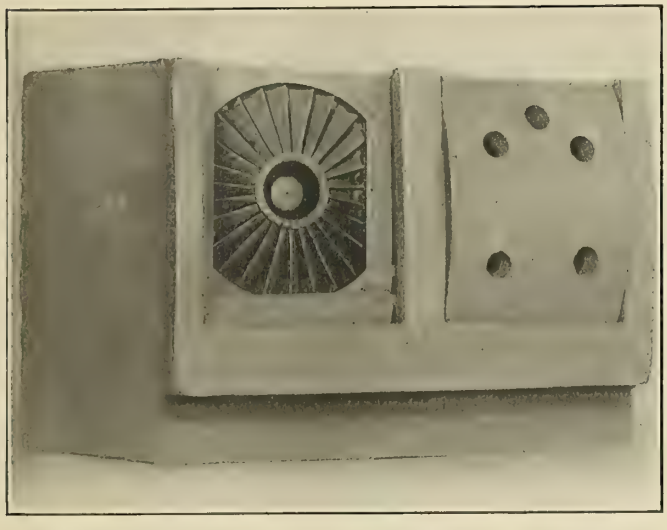


FIG. 13.—FITTING OF OIL BURNERS FOR COAL AND OIL, REAR VIEW

showed any signs of distortion, and all tubes and headers were free of blisters. All baffles were in good condition and properly placed."

It may be interesting to note that the wetness of steam referred to in the Board's report did not exceed as a maximum 81 hundredths of 1 percent, as shown in the results of the tests which are given in Table II.

Oil and Coal in Combination.—The writer does not believe that two such different fuels as coal and oil can be burned in the same furnace at the same time with results in efficiency equal to those which can be obtained with either fuel alone. The problem, always difficult, of securing complete combustion of the volatile hydrocarbon becomes more difficult, and one fuel inevitably interferes with the other. The injection

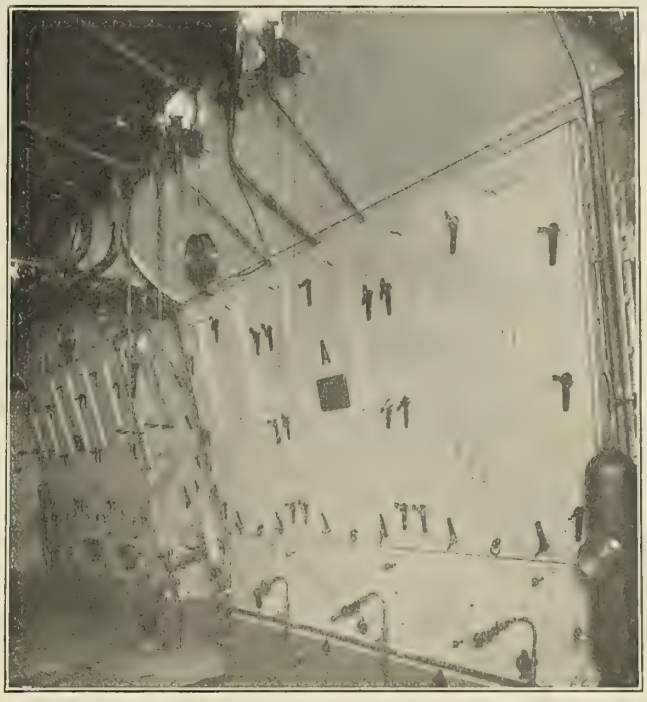


FIG. 14.—U. S. S. ARETHUSIA, FUEL OIL SYSTEM

of an oil spray over a coal fire is, however, a most effective way of boosting up the capacity of the boiler, and for this purpose the combination has a wide field.

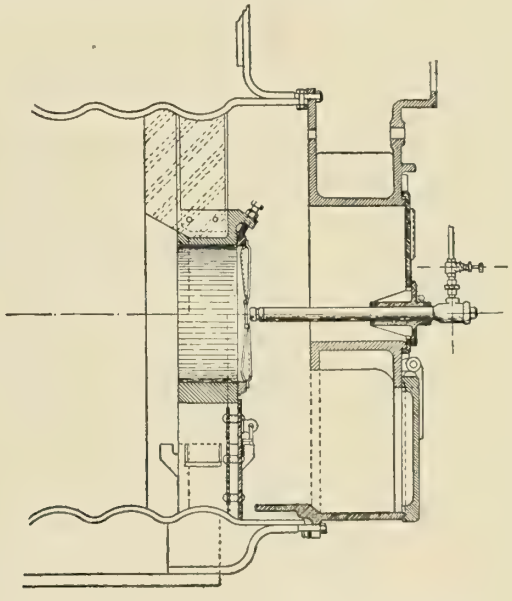


FIG. 15.—HERMAN FRASCH INSTALLATION

As noted above, the United States battleships *Wyoming* and *Arkansas* were to burn coal and oil in combination. Consequently, after completing the oil tests we turned our attention to the best method of getting the two fuels to work together. Obviously the most satisfactory location for the burners is between the fire doors. But owing to the fact that the ash pan, grate bars, and bed of coal and clinker on the grates combine to take up considerable space, there is bound to be

a somewhat limited head room in the furnace. For this purpose the flat spray burner is well adapted, but the flat spray mechanical atomizer, as so far developed, does not at satisfactory capacities give as fine a spray as the round or conical spray atomizer. It is, however, possible, as we have found by experiment, to alter the shape of the flame from the round flame burner by manipulating the air for combustion. Thus, if the air be admitted through a horizontal slot, the flame will be diminished in width and increased in height, and, vice versa, if the air be admitted through a vertical slot the flame will be spread out sideways and decreased in height. The latter effect is what is desired in the combination of coal and oil. Consequently, while still retaining the whirling motion of the air, which we have found effective, we modified the impeller plate to approach the vertical slot idea, and in this way we were able to broaden out the oil flame over the coal bed so as to burn .6 pound of oil per square foot of heating surface per hour in combination with a rate of combustion of 25 pounds of coal per hour per square foot of grate surface. This device is shown in Fig. 8 and Fig. 13. The space between the fire doors is occupied by a casting designed to carry two impellers side by side, each of an oval form as indicated. This casting is air-cooled and is provided with slide ways so arranged as to permit of substantial cast iron shutters being pushed up in front of the impeller plates when the burners are not in operation, thus effectually shielding the impellers and the burners themselves from the radiant heat of the furnace. The burners and impellers therefore remain constantly in place while burning coal, and it is only necessary to put pressure on the oil line, slide the shutters down out of the way, and turn on the oil when the latter is needed.

Fig. 11 shows the front of one of the boilers of the United States battleship *Wyoming* as installed in the vessel.

If it is desired to operate with oil fuel only, the coal fire is allowed to go out, leaving the grate bars covered with ash and clinker to protect them from the heat, and the oil burners are lighted exactly as if no coal was used at all.

Natural Draft.—In the experiments described above forced draft had been available, and there is no doubt that the high velocity of the air thus secured is a material assistance in securing the proper mixture with the oil spray. It is often desirable, however, to run under natural draft conditions, particularly when the vessel is in port. For this reason a supplementary series of experiments was inaugurated for the purpose of adapting the apparatus to the requirements of lower draft pressures. The principal changes found necessary were a modification of the shape of the blading and an increase in size of the impeller plates.

The boiler room of the United States Navy oil-tank ship is shown in Fig. 14, the two Babcock & Wilcox boilers replacing two double end Scotch boilers. This vessel is one of the first fitted with mechanical atomizers operating under natural draft.

Scotch Boiler Installations

The round spray mechanical atomizer and impeller plate are well adapted for use in the corrugated furnaces of the Scotch boiler, and the Babcock & Wilcox Company has made installations for both natural draft and Howden forced-draft vessels fitted with this type of boiler. Fig. 15 shows the arrangement adopted for the steamer *Herman Frasch*, of the Union Sulphur Company, recently altered from coal to oil burning. This vessel is now developing an indicated horsepower on less than a pound of oil.

(To be concluded.)

Monthly Shipbuilding Returns.—The Bureau of Navigation reports seventy-eight sailing, steam and unrigged vessels of 17,418 gross tons built in the United States and officially numbered during the month of December.

Freight Handling at Steamship Terminals

One of the most important problems confronting steamship men at the present time is the direct transference of miscellaneous package freight from railroad cars or a warehouse at a steamship terminal directly to the hold of a steamship, or, vice versa, the transference of a ship's cargo directly from the hold to railroad cars or a warehouse on shore. The present method of relying largely on manual labor and rehandling for this work is recognized as one of the chief causes of high transportation rates.

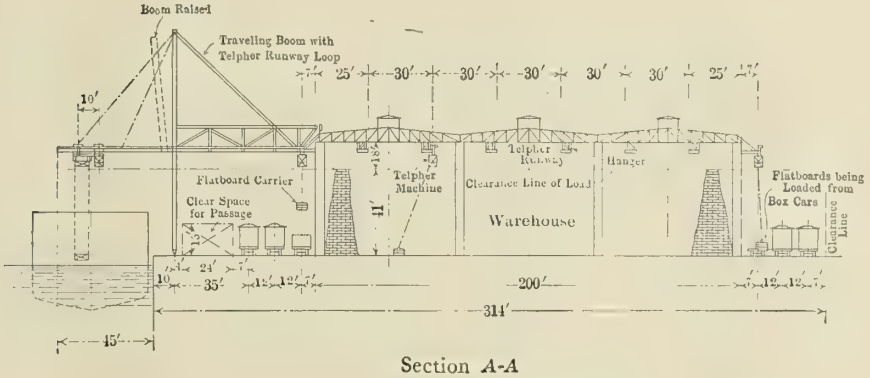
An arrangement has been suggested by the Link Belt Company of Chicago involving the use of a telpher system applied in combination with an ordinary traveling gantry crane having a boom which is equipped with a telpher runway projecting out from the end of the dock over the hatch of the vessel. The plan shown in Fig. 2 gives a general idea of the arrangement of this system. Railroad tracks extend on each side of the warehouse and a telpher runway almost completely encircles the warehouse and is connected at one end of the building by switches with other runways inside the warehouse, thus forming an endless path for the telpher machines to travel on. The traveling booms, *A* and *B*, which extend out over the vessel's hatches, each carry U-shaped telpher runways provided with sliding switches which connect with the main line runway, so that the telphers can be shunted out on to the boom over the hatches of the vessel, thus completing a circuit which enables the telpher to transfer the package freight loaded on flat board carriers directly from the hold of the ship to any part of the warehouse or directly to the freight cars on the tracks. The gantry cranes, of course, can be moved along the dock so as to be placed directly opposite the hatch of the vessel. With this arrangement loading and unloading can be carried on simultaneously, and the time the vessel is held at the dock for its cargo is greatly reduced.

In the arrangement shown, the length of the path traveled by each telpher in completing the circuit is 2,200 feet, and the time required for it to hoist its load in the warehouse and travel entirely around the circuit and deposit its load in the hold of a vessel is about 7½ minutes. High speed hoists are installed on the telphers for rapidly raising and lowering the loads, and it is claimed that by this system a vessel can be loaded or unloaded at the rate of from 1,000 to 3,000 tons or more per day of ten hours. The cost of transferring freight from the holds of vessels to any part of the warehouse or railroad cars is stated to be from 3 cents (1½d.) to 6 cents (3d.) per ton, depending upon the unit load carried. This cost covers power and wages of the operator, but does not include the labor of loading or unloading the flat board carriers. It is evident that since all rehandling by the ship's winches and all trucking by hand is eliminated, the cost of handling freight is reduced to a minimum.

The telpher system is nothing new, and has been so frequently utilized in general warehouse installations that its application to steamship terminals can be accomplished with a good guarantee of the results which can be obtained. The installation illustrated in Fig. 1 was made by the Brown Hoisting Machinery Company, of Cleveland, Ohio, and illustrates the adaptability of the general telpherage system to general warehouse or steamship pier needs.

Lloyd's Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping, which take into account only vessels the construction of which is actually begun, show that excluding warships there were 542 vessels of 1,970,065 gross tons under construction in the United Kingdom at the close of the quarter ended December 31. The tonnage now under construction is about 123,000 tons more than that which was in hand at the end of the last quarter, and exceeds by 451,000 tons the tonnage building in December, 1911.

FIG. 1.—BROWNHOIST TELPHER SYSTEM INSTALLED IN WAREHOUSE



Section *A-A*

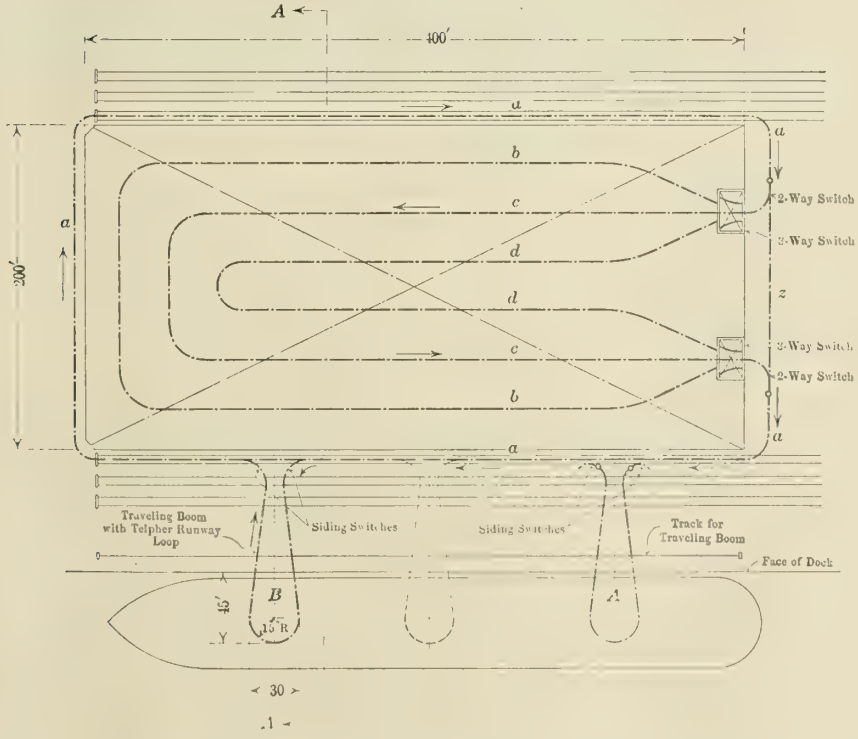


FIG. 2.—GENERAL ARRANGEMENT OF A TELPHERAGE SYSTEM ON A STEAMSHIP PIER

The American-Built Steam Yacht Lydonia

BY A. S. REED, JR.

This yacht is the second of two vessels of the same name built for William A. Lydon, of Chicago, by the Pusey & Jones Company, Wilmington, Del., and designed by William Gardner, of New York City. She is noteworthy as being the largest and finest full-powered steam yacht built and engined in the United States within the last ten years, and goes to show that Mr. Lydon's confidence in patronizing home industries has not been misplaced.

The contract for the vessel was received Feb. 20, 1911. She was launched July 25 of the same year. The contract was practically completed by Dec. 30, 1911, but she was compelled to stay in harbor at the builders' wharves on account of the heavy ice filling the Delaware River at that time. Her gross tonnage is 497, and in most cases her construction scantlings exceed Lloyd's and the American Bureau requirements. She will be used considerably on the Great Lakes and Atlantic seaboard, and has consequently been very strongly constructed. The principal dimensions are as follows:

Length over all	212 feet 6 inches.
Length on load waterline	170 feet 6 inches.
Beam, molded	26 feet 6 inches.
Depth, molded	16 feet 3 inches.
Draft, extreme	12 feet 6 inches.

The main deck is carried in a clear sweep from stern to within about 65 feet of the stem, whence it is continued forward by a forecastle deck at the height of the bulwarks forming a flush deck, and thus carrying out an unbroken sheer line, and affording increased freeboard and buoyancy forward. A continuous deck house is carried from within 60 feet of the stern to the break in the forecastle, in which are located the music room, library, engine and boiler casings, drying room, deck toilet, galley, pantry, deck storeroom, main dining saloon, paint locker, etc. These various rooms are all accessible by a continuous inside passageway on the starboard side of the ship, as is usual in modern practice. The upper or shade deck is carried from side to side of the vessel, allowing ample stowage for the boats carried and affording fine deck space. On the shade deck is located the chart house, which will also be used as a smoking room, and which is accessible from the main deck by a stairway. The ship will be navigated from the bridge on top of the smoking room, where are located binnacle, telegraphs, speaking tubes, steering column, etc., the deck being carried to the side in the shape of a flying bridge, supported from the shade deck.

The accommodations for owner, guests, officers, etc., are located on the lower or berth deck, and consist of ten staterooms and four bath rooms, including a large double stateroom aft, and not taking into account the officers' quarters, which consist of six staterooms and an additional bathroom. In the guest quarters is also fitted a large linen locker.

Hull Construction

The hull is constructed of mild open-hearth steel, and all material contributing to structural strength has been fully up to the United States standard for this class of work, the very best commercial practice governing all workmanship. The keel is formed of an 8-inch wrought iron bar, fitted in the longest possible lengths and carefully scarphed to the stem and stern frame, length of scarphs being about 21 inches.

The stem is a steel casting in two sections scarphed together 7 inches deep, of hollow section, sharp at the fore edge and carefully rabbited to receive the plating.

The stern frame is a forging in one piece, the propeller post being 8 inches deep and the rudder post 7½ inches, with lugs for rudder pintles and backing stops forged on and brass bushed. The rudder post is fastened to the transom floor by heavy angle-iron lugs.

The transverse frames are formed of steel angles, evenly spaced for the full length of the ship. They are doubled in way of all bulkheads. Heel pieces of the same size as the frames, 36 inches long, are fitted for three-fifths of the ship's length amidship. Four complete belt frames are fitted, two being located in the boiler space and two under the main engine. They are of angle and plate construction, with double reverse frames on the inboard edges.

Reverse frames are located on every frame, extending alternately to the main deck and the lower side stringer, except in the machinery space, where they are carried to the deck on all frames and double across the floors.

The floors are of heavy section steel plate, 22 inches deep at the center line. In the machinery space they are of increased depth to form suitable foundation for the engines, boilers, thrust bearings, etc.

The center keelson consists of heavy double angles riveted back to back, and carried continuously on top of the floors from end to end of the ship. A sister keelson is worked intercostally throughout the boiler and engine space, clipped to the floors and shell plating and fitted at the top with continuous double angles. In addition upper, lower and bilge stringers are carried as far forward and aft as possible, formed of double angles. All keelsons are carried continuous throughout the bulkheads and stapled watertight. Bilge, or rolling keels, are fitted amidships.

The main deck beams consist of channels fitted on every frame with a crown of 7 inches in 26 feet, and securely bracketed to the frames. The lower deck beams consist of angles on every frame, well bracketed to the frames and stanchioned to keelsons. Lower deck beams have no camber. Fore and afters, of beam scantlings, are fitted in way of all hatch openings. The shade deck beams are steel angles, closely spaced, fastened to the house shelf and tied on the ends with a continuous stringer plate.

The ship is sub-divided transversely by five watertight bulkheads and three non-watertight bulkheads extending from the keel to the main deck. The bulkhead plating is worked in horizontal strakes and stiffened by angles, spaced 22-inch centers, horizontally on one side and vertically on the other. The bunkers, which consist of one transverse and two side bunkers, are designed to stow 125 tons of coal, and are constructed substantially the same as other bulkheads, except that they are stiffened on one side only by vertical stiffeners and made dust proof.

The main deck stringer plate is 30 inches amidship, reduced to 20 inches at the ends and fastened to the sheer strake by a heavy angle. Tie plates are worked under the sill of the main house, and diagonal deck ties are fitted forward and aft; 12½-pound partner plates extending over three beam spaces are fitted at the mast, and extra foundation plates are fitted under the windlass and bitts. The main deck over the boilers is completely plated over with 6-pound plating, and 10-pound tie plates are worked in the way of all deck hatches and coaling scuttles. Four coaling scuttles are fitted for filling the bunkers on each side of the main deck, and the latest improved watertight covers are provided and supplied with coaling hopper.

The ship is plated flush above the load waterline, and in, out and in strakes below. Fresh water tanks are built in the hull, with a total capacity of 5,000 gallons. The forward tank

is located forward of the transverse bunker, and the after one directly aft of the engine space, being recessed at the center line to suit the thrust bearings. These tanks are fitted with baffle plates and manholes for access, and every provision made to insure water-tightness. A watertight door of government style is worked in the fire-room bulkhead, fitted to operate from either side.

The wood deck house is built upon a skeleton framework of steel, the front of the house being a complete steel bulkhead, well stiffened by angles and sheathed with teakwood. Four athwartship steel bulkheads, suitably stiffened by angles, are worked in the house for transverse stiffness.

Above the load waterline the hull is evenly cemented and covered with four coats of paint, the first coat being red lead mixed with linseed oil. All built-in tanks were tested with a head of water to the height of the bulwark rail for absolute water-tightness.

Aft of the crew space are the officers' quarters, consisting of six staterooms, one bath room and lobby, and entered directly from the forecastle deck by means of companion hatch above. The lobby is finished in butternut and the officers' staterooms are cork painted in white, with butternut trim and furniture.

Forward of the cross bunker and next aft of the officers' quarters come the owner's accommodations, consisting of two large staterooms, occupying together the full width of the ship, a smaller stateroom, a bath room and a lobby, reached from the main deck passage by means of a curved stairway of solid African mahogany. The lobby is also finished in selected African mahogany, handsomely paneled and matched for color and grain, rubbed to a dull, smooth finish. The owner's

STEAM YACHT BUILT FOR WILLIAM A. LYDON BY PUSEY & JONES COMPANY FROM DESIGNS BY WILLIAM GARDNER

Interior Arrangement

The space forward of the collision bulkhead is fitted up as a paint locker, with access through a watertight scuttle in the forecastle deck and by means of a steel ladder. On the berth deck next aft of this bulkhead comes the forecastle, with accommodations for a crew of fifteen men and fitted with galvanized steel pipe berths arranged to swing upward when stowed. In the after end of this space is fitted a stateroom with two built-in berths for the use of the quartermasters. Access is obtained by a steel ladder from the hatch in forecastle deck, and ample ventilation secured by a cowl ventilator and four air ports on each side of ship. A hatch in the berth deck leads to a wash room and toilet for the crew in the aft-end of lower forecastle, in which are also located four additional swinging pipe berths for the crew. Directly aft of the collision bulkhead and beneath the berth deck is located the chain locker, of sufficient size to stow 150 fathoms of chain cable, the chain pipes passing through the forecastle, and raked forward to minimize noise in handling chain.

staterooms are finished in solid white mahogany, and contain large, specially designed canopied beds, divans and bureaus fitted with mirrors of beveled plate glass. Roomy wardrobes are built in each stateroom. The bath room is finished entirely in white, the floor and walls being tiled to height of belt rail with white glazed tiling fitted with sanitary base and of a neat pattern. This bath room contains a tub, lavatory and toilet to match finish of room, and is ventilated and lighted by a lean-to skylight on main deck at side of house and by air ports.

The guest's living quarters are on the berth deck aft of the machinery space and separated from it by a heavily insulated bulkhead to deaden the sound. They consist of six single staterooms, three bath rooms and a large double stateroom and linen locker. They open into a fore and aft passageway, which is accessible by a stairway and balustrade from the after end of the library on the main deck. The berth deck passage is finished in paneled African mahogany, the panels extending from deck to deck, vertically, forming a pleasing system of single paneling, all the material being selected stock, rubbed to a dull, smooth finish. Staterooms 1 and 2 together occupy the full width of the ship, and are finished in solid white mahogany, with specially designed built-in beds of the canopy type, bureaus with beveled glass mirrors and cush-

ioned settees, fitted with lee-boards. Ample clothes space is provided in the shape of built-in wardrobes, and cheval glasses are fitted in the wardrobe doors.

State-rooms 3, 4, 5 and 6 are finished in white panel work, with African mahogany trim and furniture. The ceilings are neatly paneled. Cushioned settees, bureaus and wardrobes are all of special design.

Farthest aft is located the double stateroom extending the entire width of vessel, finished in African mahogany and ventilated by a large skylight above on main deck. A large double bureau and dressing table is built against the after bulkhead in this room, and large clothes lockers fitted on either side of the ship.

The three bath rooms are finished similarly in white, with vitreous tile of selected pattern on the floor and glazed tile on walls, with mahogany cap rail, the tiling being of pleasing color and pattern. Each room is fitted with the latest improved type tubs, lavatories, etc., and are connected by communicating doors with all the staterooms.

Refrigerating Plant

In the after end of the lower forehold a large refrigerating room is built into the ship, completely lined with sheet lead and heavily insulated with 3-inch thickness of block cork, every provision being made to secure a first-class icebox. Compartments for ice, meats, vegetables and other perishable stores are provided. Arrangement has been made for refrigerating machinery which will be installed in the near future.

Main Deck Arrangement

In the forward end of the main deck house is located the dining saloon, extending the entire width of the house and affording a complete view forward and on each side. It is finished in selected teak, handsomely carved and paneled, and of very attractive design. It contains a large circular extension table of polished teak, capable of seating sixteen persons. In the forward end of room is built a teak serving table with lockers, etc., under and containing a coil of steam pipes for heating purposes, all concealed in the wood work. In the after end is built a sideboard or buffet of teak, beautifully carved and fitted with drawers, lockers, etc., the upper portion consisting of closets, with leaded glass doors of special design. The solid substantial effect of the furniture of this room adds greatly to its appearance. The ceiling paneling is finished in dull gilt. Leading aft from the dining saloon on the port side is a door to the pantry, which is connected with the galley.

Aft of galley is the fiddley, on the starboard side, aft of which is located a large drying room fitted with lines and hooks, and aft of this room is a deck toilet. On the port side an oil locker and lamp room is located leading directly off the main deck. Next aft is the upper engine room, the sides of which are finished in dull white panel work. On the starboard side is a large observation window, affording a view of the upper engine room from the deck passage.

The after end of deck house is divided into two large rooms intended to be used as music room and library. The forward room is fitted up at the sides with bookcases with leaded glass doors to the level of the deck house windows. This is a very roomy apartment, and being furnished with a plentiful supply of light from the dome skylight overhead should prove a comfortable living room. The after room has a conveniently placed built-in sofa, and the main mast which passes through this room is handsomely ceiled over. In the after starboard corner is the stairway and balustrade to lower deck accommodations.

Both of these rooms are paneled in solid African mahogany, finished in a dull polish. The ceilings are finished in dull gilt. The main deck passageway on the starboard side of the deck house is finished in African mahogany panel work, the panels being of a single vertical type and finished dull. This type of paneling is carried throughout the ship in owner's quarters and lower deck passage aft, and gives a very pleasing effect. Ceiling in passageway is of light buff color.

From forward end of main deck passage a stairway leads to chart house on shade deck. Chart house is built of solid teak outside and finished inside in African mahogany. This room is intended to be used also as a smoking room.

Outfit and Equipment

A double-cylinder steam yacht windlass, made by the Hyde Windlass Company, is fitted on the forecastle deck for handling anchor chain. It is also equipped with gypsy heads for working falls leading from power launches and heavy boats on the shade deck, which are carried forward to the windlass through snatch blocks, chocks, etc. This arrangement admits of handling the heavier boats by means of the windlass.

The *Lydonia* is equipped with a steam steering engine of the Williamson type. It is located in the engine room and connected with the steering column on bridge by means of heavy turned steel shafting and specially designed gearing, the unusual feature of these gears being that they are fitted entirely in the shops and completely alined before being erected on the ship. Leading from the steering engine to the rudder quadrant are 1-inch diameter steel wire cables carried through brass tubing, filled with heavy grease, thus increasing the life of the cable and at the same time eliminating noise in the quarters.

On the main deck aft, directly over the rudder head, is fitted a hand steerer of the diamond screw type, with 48-inch steering wheel, the gear being encased in a polished teak wood box.

The usual system of mechanical telegraphs and speaking tubes is fitted of the Corey type, and also includes a speaking tube from pantry to the provision compartment in the forward hold.

The outfit of launches and small boats consists of a 28-foot owner's launch, a smaller 20-foot power launch, an 18-foot cutter, a 14-foot dinghy and two 21-foot life boats. The owner's launch is powered with a 30-horsepower Holmes motor, giving the boat a speed of about 18 miles an hour. The smaller launch is powered with a lighter motor of the Bridgeport make.

Machinery

The main engine is of the vertical, inverted, direct-acting, triple-expansion type, with four cylinders. The diameters of the cylinders are 16 inches, 26 inches and 30 inches, all with a common stroke of 24 inches. All parts are designed to sustain a working pressure of 200 pounds gage. The main valves are of the piston type, operated by the Stephenson link motion with double bar links. Each main piston has a piston rod with a cross-head working in a box guide. Back and front columns are turned steel forgings, well braced. The crankshaft, piston rods, connecting rods and working parts generally are of open-hearth wrought steel. The reversing gear consists of a steam cylinder 7 inches diameter and 12-inch stroke, acting through a piston and cross-head directly on an arm on the reverse shaft and controlled by a lever at the starting platform. The throttle valve is balanced and of the double poppet type, operated from the starting platform and next to the reversing lever. The crank, thrust and line shafts are 8 inches diameter, finished; the tail shaft 8¼ inches diameter, solid forged steel throughout, the cranks having a throw of 12 inches and the thrust shaft having collars forged on in the usual manner. The propeller shaft is incased in a brass pipe, shrunk on, and made watertight in way of the stern tube, and turned cast bronze sleeves fitted in way of the bearings.

A complete water service and lubrication system is fitted, consisting of multiple-feed oilers with sight-feed cups. The multiple-oiler is filled by gravity from a tank in the upper

engine room. Grease cups are used extensively. The water service is of polished brass pipes to all bearings, crank, thrust bearings, etc. The thrust bearing is of the horseshoe type, with cast iron base, designed to hold oil and water. Shoes are of cast steel, lined with white metal and fitted with oil cups. Spring bearings to support line shafting are of cast iron, lined with Babbit metal, and fitted to be oiled from engine room if necessary.

The turning gear consists of a cast iron worm wheel fitted in the center of the after engine coupling and operated by a detachable composition worm gear with ratchet and lever. The condenser is of the cylindrical type with cast iron body and water ends. The tubes are of brass, ¾ inch outside diameter, tinned inside and out. The propeller is four-bladed, cast solid, of manganese bronze.

Electric Outfit

There are fitted two General Electric generating sets of 10 and 4-kilowatt capacity. A switchboard of marbleized slate is located in the upper engine room on the after bulkhead, and fitted with all necessary switches and instruments, etc.

Chloride accumulators of the marine type, in vulcanized rubber jars with caps, are fitted in lead-lined boxes and installed in a battery room in the after-hold, with ventilation by means of mushroom ventilators on main deck. On the bridge is installed a 14-inch searchlight projector. The searchlight is of 20 amperes capacity and is fitted with a lens mirror. In addition to the usual oil lamps the navigating, binnacle, telegraph and gangway lamps are fitted for electric lighting, all with watertight receptacles. All switches for lights and bell calls throughout the ship are of the flush push button type.

Boilers

The main boiler is of the cylindrical, marine firetube type, constructed for a working pressure of 185 pounds, and tested to 225 pounds hydraulic pressure. It is 14 feet 3 inches diameter, the shell plates are 1 5/16 inches thick, of a tensile strength of 60,000 pounds. The boiler has three corrugated suspension furnaces of the Morison type, with separate combustion chambers. The tubes are 3 inches outside diameter, lap welded, charcoal iron.

The donkey boiler is of the vertical type, 4 feet 9 inches inside diameter. It has shell plates of ⅜ inch thick steel plate, and is constructed for a working pressure of 150 pounds. It has stack connection with the main funnel, and is located in the lower fire-room convenient to the coal bunkers. In the lower fire-room is also located an ash ejector of the hydropneumatic type, fitted with all necessary pipes, valves, etc., for discharging overboard. Arrangement is also made for hoisting ashes by hand to main deck.

Pumps and Auxiliaries

The air pump is a Simplex vertical single-acting beam air pump, made by the Blake & Knowles Steam Pump Company. The circulating pump is of the side suction, centrifugal type, made by the Morris Machine Works. It is direct connected to a vertical engine, the pump having a vertical discharge and fitted with a composition runner. It is capable of supplying at 250 revolutions per minute 1,200 gallons per minute.

The main and auxiliary feed pumps consist of two Admiralty type vertical duplex pumps, composition fitted, for a working pressure of 200 pounds. They are manufactured by Blake Steam Pump Company.

The bilge, ballast and fire pump is of the horizontal duplex piston type, composition fitted, for a working pressure of 175 pounds. In addition to the ordinary connection this pump is piped to supply circulating water to the condenser in case the circulating pump is out of order.

The donkey boiler pump is a Blake horizontal, duplex piston pump, composition fitted.

The sanitary pumps are of the horizontal, duplex piston type, fitted with governors to regulate the water pressure at the service tanks.

A multi-coil feed-water heater is installed, capable of heating the feed-water to 225 degrees F., using exhaust steam from auxiliaries.

The forced draft system is of the closed ash-pit type, and consists of a Sirocco fan with single inlet, direct connected to a vertical inclosed steam engine, furnished by the American Blower Company.

The hot well and filter box are of galvanized iron and fitted with an automatic regulating valve direct connected to feed pumps.

The main steam and main engine piping are of copper with composition flanges. The piping generally is of brass or copper. All salt-water piping is of copper, as are the feed lines and blow-off piping. The fresh water piping is of galvanized iron for sizes of 2 inches or under, above this size of copper. All valves of 2½-inch size and under are of composition, and above this size are composition fitted. Lunkenheimer high-pressure valves are used throughout.

Westinghouse High-Speed Reduction Gear.—The largest direct-current turbo-generator set yet constructed has been built by the Westinghouse Machine Company and the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., for one of the stations of the Cleveland Electric Illuminating Company, Cleveland, Ohio. The speed of the turbine is 1,800 revolutions per minute and the rated capacity of the generator 3,750 kilowatts. By interposing a Westinghouse reduction gear with a ratio of 1 to 10 between the turbine and the generator, the latter is driven at 180 revolutions per minute. The reduction gear embodies the hydraulically-supported "floating" pinion frame of the type recently installed in the naval collier *Neptune*. The generator efficiency being 94 percent the gear transmits 5,350 brake-horsepower, although on several occasions the load has been in excess of 6,000 horsepower. It is expected that this plant will demonstrate that two gears of this size, each with two pinions driven by separate turbines, will be sufficient for driving the largest battleships of the *Dreadnought* class. The above gear does not exceed in capacity the experimental set tested at the Westinghouse Machine Company's works in 1909, but the reduction ratio is twice as great, and the turbine speed is 20 percent higher.

Submarine Contracts.—Contracts for eight submarines were awarded at the Navy Department Dec. 31. The work is divided between the Lake Submarine Boat Company, Bridgeport, Conn., and the Electric Boat Company, Groton, Conn., the former to build three and the latter five boats. At the present time eight submarines are under construction on the Pacific Coast and seven on the Aatlantic coast.

Dutch Shipping Exhibition.—The first Dutch shipping exhibition, which is to be held at Amsterdam from June to September, 1913, and which has the material support of the Government of the Netherlands, was organized to mark the anniversary of the Treaty of Ghent, which made Holland an independent kingdom, and also to celebrate the opening of the Peace Palace at The Hague.

Correction.—On page 13 of our January issue in the article on "Experiments on the *Fulton* and *Froude*," by Prof. C. H. Peabody, the formula for indicated horsepower, as printed, contains a redundant factor, *L*.

Marine Turbine Operation and Economy

BY LIEUTENANT-COMMANDER H. C. DINGER, U. S. N.

In practice it has been noticed that there are often very wide variations in the steaming economy of similarly engined turbine vessels, especially at low and medium speeds. The popular belief, largely fostered by the literary campaign of the turbine promoters, is that the only manipulation of the turbine plant lies in the throttle valve. This is decidedly in error, and intelligent operation and management may expect to reap the same substantial gain that it can in other installations. As a matter of fact, the most particular care and precise attention to details are required to obtain the most satisfactory results.

In connection with the operation of marine turbines there are various practical points of operation not largely touched upon in turbine literature. Many of these things have developed from the experience gained in operating the new turbine battleships and destroyers, and have become topics of discussion among those interested. Most of this experience has been with the Parsons turbine, since the majority of the new battleships and destroyers have turbines of that type.

Perhaps the most radical development over previous practice abroad is the so-called quick method of warming up. The original practice in warming up turbines was to turn steam on very slowly or to admit steam of low-pressure, and then allow the turbines to heat up gradually without attempting to move the rotor, or only moving the rotor occasionally by means of jacking gear. Then after five or six hours, when it was believed that all parts were properly heated up, to turn the rotors over with steam. This practice has during the last few years been superseded by what has come to be called the "Quick method" of warming up. This method was apparently first developed in connection with destroyers, where the necessity for getting underway on short notice is particularly present. The elements of this method are embodied in the following set of instructions which have been successfully used in practice, and a similar method is now largely used on vessels using Parsons marine turbines. Account is to be taken of the fact that this set of instructions applies particularly to a Parsons three-shaft arrangement fitted with high-pressure and intermediate-pressure cruising turbines.

Warming Up Turbine Engines

Never try to warm up any of the turbines with auxiliary exhaust connection. Auxiliary exhaust may be turned into turbines only after they are warmed.

Drain water from lubricating oil settling tanks.

Open all drains on main steam lines and also turbine drains.

Open auxiliary exhaust to second expansion of main high-pressure turbine in order to drain off water which has collected; close when water has been drained off.

Start oil circulating pump, bypassing cooler, and see that all turbine bearings and main circulating pump bearings are getting oil.

Start main circulating pump slowly.

Start one air pump slowly, obtaining about 5 to 10 inches of vacuum on main condensers. Do not have more vacuum, for otherwise the turbine may speed up when steam was admitted to them in warming up, and it is necessary to stop quickly if anything rubs.

See jacking gear out.

Open bulkhead stop valves and see that self-closing valves on main high-pressure and high-pressure cruising turbines are open. Open one boiler stop about one-half a turn and let steam blow through system for about three or four minutes, or until throttle valves are thoroughly heated. If turbines start to turn it will be necessary to close valves, but this is not likely to happen.

After throttle valves are thoroughly heated, close them and let steam pressure rise to about 150 pounds.

If all turbines are connected up, give main high-pressure turbine jets of steam, just sufficient to turn it over; do this several times, so that it will be warmed up thoroughly and evenly. Then do the same, first with port low-pressure, second with starboard low-pressure, third with intermediate-pressure cruising, and last with high-pressure cruising turbine, between times giving the backing turbines a few jets of steam.

If turbines do not readily turn, steam may be put on cruising and low-pressure turbines at same time to start them. Keep blowing steam through the different turbines for 20 minutes or a half an hour; by this time the entire system should be thoroughly warmed up. The idea of opening one boiler stop about one-half turn is to have only just enough steam to turn the turbines over slowly and prevent them running away, which might happen if full pressure was admitted. In order to prevent any of the moving parts of the turbines from touching on the fixed parts, *thorough* and *even* warming up is absolutely necessary, and this can only be done when the rotors are moving so that the steam comes in contact with all parts.

Steam may be turned on the glands any time during the warming up of the turbines; about 1 pound is sufficient.

After 20 minutes or one half hour, when turbines are thoroughly warmed, open boiler stops and get permission to try engines from bridge. Take micrometer readings while engines are being turned over.

When everything is ready, report department. Keep putting jets of steam through all turbines while waiting for orders, so as to keep them warm.

A few minutes before getting under way, the bridge should notify the engine room, so that the main air and circulating pumps may be speeded up and the augmentor cut in.

The above quick method is in very general use on recent destroyers. It originated with the Bath Iron Works, and has been found to be very satisfactory in practice, and a similar method will no doubt be adopted by nearly every Parsons turbine installation when it is discovered that the long and tedious process of slow warming up is not only unnecessary, but also more dangerous.

The danger of touching blades in starting up is due to lack of uniformity of temperature, and is not a question of low temperature. The parts might all be ice cold, but as long as all parts were uniformly cold, no touching can result. In order to heat up uniformly heat must be distributed to all parts. Admitting steam, though of very low-pressure, to a turbine without revolving the rotor is bound to heat some parts a great deal more than others. Of course, if the process is long enough, eight or ten hours, a rather uniform condition of temperature will be obtained. However, by revolving the rotor by steam, the steam is bound to be distributed all along the blading, both longitudinally and radially, and all parts are heated in a very uniform manner. Revolving the rotor by means of jacking gear is of little or no use, unless some steam is entering the turbine while this revolving is taking place. The rotation of the rotor should be used to distribute the steam, and hence the heat, over all the steam contact surfaces. This can be done very efficiently by injecting gusts of steam into the turbines and thus starting it revolving. This really

warms the turbines uniformly, and as long as heat is uniformly distributed circumferentially it does not make much difference as to the distribution of heat longitudinally, except that there ought to be a gradual fall in temperature from one end of the turbine to the other.

There is thus no need for long periods of preliminary heating. The main thing is to get the turbine revolving by the action of the steam, or to have the rotors revolving while steam is being admitted.

Neither is it believed that the size of the turbine should make any particular difference; though of course it will take a larger turbine longer to get up to its final working heat. If desired the process of warming up by puffs of steam can be continued longer than with a smaller turbine.

On large vessels this method may be modified by first revolving the rotors by means of the jacking gear for half an hour or more, while the gland steam is on and the throttle bypasses opened slightly. After this is done, then throw out the jacking gear and move the turbines successively by giving them puffs of steam with the throttle, as in the quick method of warming up. With large turbines there is not much danger of the turbine running away. A fairly high vacuum can be carried while trying out turbines, and a fairly good throttle opening is required to start them turning.

This method can be used where power jacking gear is provided, and is thoroughly safe, since the rotor is being revolved while steam is being passed through the turbine. The danger in warming up comes from admitting steam without revolving the rotor. This causes a local and uniform heating and a consequent distortion of some part which may touch when the rotor is next revolved.

The slow method of warming up is apparently the most dangerous, since by admitting steam at one point and only moving the rotor occasionally uniform heating is hardly posssible, and there is no way of telling how long it will take the turbine to acquire its uniform expansion. It may take two, three, six or eight hours, and depends upon the variable amount of steam that may be admitted.

In the slow process of warming up we begin by distorting the rotor and casing by heating some parts more than others, and then wait till the other parts get up to a uniform temperature by conduction. In the quick method we do not distort the turbine, but simply gradually heat up all parts in as nearly a uniform manner as possible.

From results of practice there is not yet known any case of stripping blades due to warming up by quick method, while cases of stripping due to improper warming by the slow method are many. The slow method is no doubt safe if plenty of time is taken—five to six hours; but life is too short to employ such a waste of time.

Operation of Turbines

Handling of Throttle.—A turbine requires more time to speed up to the required revolutions, and also does not stop as promptly as a reciprocating engine. Time should be given to work up to power, and sudden opening or closing of the throttle is not deemed advisable. A sudden opening of the throttle is liable to cause the joints around the glands to leak, and may also cause priming, which, if very bad, may cause some of the blades to be loosened. After steady speed has been secured, constant revolutions can be maintained by keeping a constant receiver pressure, but while the speed is being changed the receiver pressure does not give much of a guide. Throttles may sometimes stick, especially the backing throttle, when not used for a long time. Opening the bypass will usually warm it and loosen it up.

Clearances.—The dummy clearances will change from various causes. The chief cause for change is the warming up, or cooling of the turbine, and whether the steam thrust or propeller thrust is predominating. On starting out clearances are usually larger than after the turbines have reached their full working heat. At low power the propeller thrust predominates and the clearances are low, due to the fact that the rotors are in. The depth of the water will also affect the position of the rotor, since it will alter the thrust. At high speeds the steam thrust will predominate and the rotors will move out, causing increased clearances. The combination in use and the proportionate power on the different turbines will affect the position on the rotors. This being the case, the rotor can be made to change its position, more or less, by a change of combination and by admitting steam in one place or another. Thus a low-pressure on one side may to some extent be forced out by putting more auxiliary exhaust into it. This can be done by shutting it off on the other side, or by cutting some out of the feed heater. A main high-pressure turbine can be moved out when in cruising combination, by opening its throttle bypass, thus giving a little higher steam pressure, and consequently a greater steam thrust, or in case a main high-pressure rotor should come in so as to be dangerous when using a cruising combination; cutting out cruising turbines and running with main plant would tend to move the rotor out. It is well to notice that the position of the rotor can thus be varied, because it may be made use of should some of the clearances become dangerously low. A safe position of rotor may possibly be secured by some manipulation of throttles and connections, as cited above.

Clearances, however, are often known to change for no manifest reason, but it is not always certain that the micrometer is read rightly. Sometimes the end of the micrometer rod becomes burred or is grooved by the rotor so as to cause inaccurate readings to be taken.

Manipulation of Gland Steam.—The high-pressure and the cruising turbine glands have leak-off connections to the condensers. Through these connections considerable steam may be lost, when it is not at all necessary. If the leakage out is very considerable, it may be necessary to open the leak-off to the condenser, but as much as possible of this leak-out should be utilized to pack the low-pressure glands which are under vacuum. If the leak-out is considerable the supply of steam to glands for steam pipe may be closed off. The amount of leakage varies with the pressure in the turbine, and also to a considerable extent with the position of the rotor. High dummy clearances apparently call for a greater supply of gland steam. In changing from one speed to another, the gland steam requires adjustment, and usually if once adjusted for a steady speed little regulation will be required, until speed is again changed.

Backing.—This should not be done too suddenly—that is, by very quick opening of the throttle. A quick opening is likely to cause priming. In backing, regard should be had for the boiler power at the time available. If only a portion of the boilers are connected, a considerable opening of the throttle will cause the steam to be taken faster than it is generated, and the pressure will be run down in a very short time. Hence it is better to start backing gently and then open up as much as possible, and still maintain a sufficient steam pressure in order that the risk of having the auxiliaries bucking may be obviated.

Securing Turbine Engines.—The forced lubrication pumps should be run for some time after the engines are stopped in order that the cool and clean oil may be at all the bearings. The air and circulating pumps should be run for several hours with the turbine drains open, in order that all possible vapor contained in the turbines may be drawn off. Turbines should be jacked to drain joints, to facilitate water in bottom of casing being drained off. The thorough drying out of the turbines in this way prevents corrosion.

While in port the air and circulating pumps should be operated for a short time every few days in order to draw off any moisture that may have collected.

(To be concluded.)

Steam Lumber Schooner John A. Hooper

The Harlan & Hollingsworth Corporation, of Wilmington, Del., has just completed and delivered a steel lumber steamer for Sudden & Christenson, San Francisco, Cal., intended for service in the transportation of lumber along the Pacific Coast of the United States. The length over all is 299 feet, length as per Lloyd's rule 284 feet, molded beam and depth are 44 feet and 21 feet 6 inches respectively, with a double bottom 3 feet 6 inches deep at the center line. The poop and forecastle have a height of 8 feet 6 inches, while the bridge has a height of 12 feet above the main deck. The propelling machinery is at the extreme stern. The vessel is schooner rigged with three masts, the fore and mizzen masts each carrying two 75-foot cargo booms, and the mainmast four 75-foot booms. Special attention has been given in designing the rigging to handle the cargo of lumber efficiently and rapidly. There is one complete steel deck and a double bottom extending all fore and aft, which, with the fore peak, is to carry oil fuel. Deep trimming tanks are fitted in the vessel so that she will draw about 11 feet forward and 15 feet aft, with all the bottom and peak tanks full. The officers, firemen and oilers are located in the poop, while the sailors are berthed in the forecastle.

The deck machinery consists of a steam capstan of Hyde make located on the poop deck for warping the vessel. The engine is 6 inches by 8 inches with a gypsy head 18 inches in diameter. A steam brake windlass of Hyde make is fitted on the forecastle deck with 9 inches by 9 inches vertical engines with wildcats suitable for handling 1¾-inch chain cable. A vertical steam steering engine 7 inches by 7 inches of the patent combined steam and hand quadrant steerer friction type is located in the poop and directly connected to the rudder quadrant through a friction device. There are also four horizontal hoisting engines of the Murray pattern, 8 inches by 12 inches double cylinder, double drum, and a towing machine located on the poop deck of the Shaw & Spiegel type, having double horizontal cylinders 14 inches by 14 inches, suitable to handle a 1¾-inch steel wire towline.

The vessel is built on the deep frame principle, so as to allow the lumber to lay up close and to avoid broken stowage. The double bottom is made oil-tight in order that fuel and freight oil may be carried. The tank top forward is raised in order to obtain continuity of strength; No. 2 tank above the tank top is arranged for carrying water ballast. The cargo hatches are of the twin type with steel covers, and the deck is provided with continuous girders fore and aft, being of single plate on each side of the hatch; this arrangement gives great strength and first-class compensation. These hatches are arranged to suit four double drum cargo winches, all particularly designed for handling lumber.

Other accessories include a wireless telegraph system, a warning signal system, a tell-tale of the General Electric make fitted in the pilot house, to indicate whether the running lights are lighted or not, and a 14-inch searchlight installed on top of the pilot house having a pilot house control. The vessel is lighted throughout by electricity. The oil-burning system is of the latest design of the Union Iron Works, San Francisco, which is a pressure system, arranged for atomizing without steam or compressed air. The vessel is designed to carry over 2,000,000 board feet of lumber on a load draft of about 17 feet 6 inches, depending on the amount of oil in the tanks.

There is no cementing in the double bottom except where water is to be carried. Two steel U-shaped fenders are filled in with pitch. Three pairs of hatches 26 feet by 14 feet and one pair 40 feet by 14 feet wide, fitted with watertight steel covers, give access to the holds. A complete pumping arrangement is provided for rapidly filling and discharging oil from the double bottom, and ballast water from the holds, while ventilation pipes for the oil compartments are fitted equal in area to the filling pipes. In the wing of the boiler room are the evaporator and ice plant equipment.

The propelling machinery consists of an inverted triple expansion, surface condensing, three-crank engine, having cylinders 21 inches, 34 inches and 56 inches diameter by 42 inches stroke, to run at about 92 revolutions per minute on a working steam pressure of 180 pounds per square inch. The air pump, two bilge pumps, and two feed pumps are attached to the back of the condenser, and are operated by a beam from the main engine, both bilge pumps having connections to the double bottom and the sanitary pipes. A 12-ton capacity evaporator is fitted up complete in the engine room with an outlet to the condenser for feed make-up. A feed water heater of the multicoil type of ample capacity is placed between the feed pumps and boilers. Steam is supplied at 180 pounds pressure by two single-ended Scotch boilers 14 feet 3 inches diameter by 11 feet 9 inches long, each having three furnaces. The propeller is a four-blade solid cast steel wheel.

Intercolonial Railway Harbor Terminals at Halifax, N. S.

BY E. A. SAUNDERS*

For years the Halifax Board of Trade has discussed the matter of a comprehensive plan of the terminals, and it is with some satisfaction that the matter has been definitely decided upon. At the present time there are nine piers in connection with the Intercolonial Railway—five of them situated at what is known as Deep Water and the balance at Richmond, about 1 mile to the north. Both sites command good positions on the harbor front, and the Richmond yards and piers are splendidly adapted for import and export trade—from this point all lumber shipments are made.

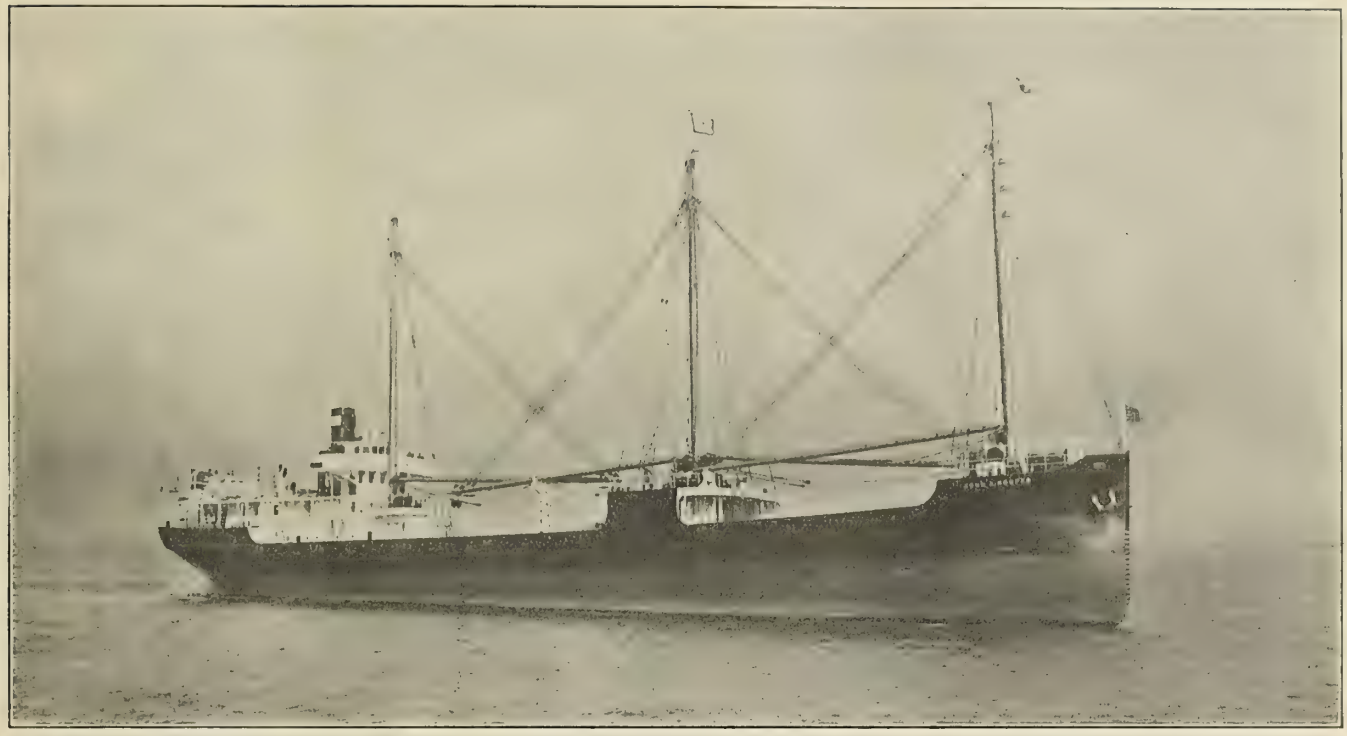
It is in connection with the piers at Deep Water that the comprehensive planning has been done. At the present time No. 3 pier is the largest, being 620 feet long and 165 feet wide. The others are 550, 490 and 450 feet long, respectively. Under the new plan these piers will be removed and four new piers constructed of reinforced concrete, three of them 800 feet long and 235 feet wide, and the other 650 feet long and 195 feet wide. The width of water between these piers will be 310 feet, 275 feet and 250 feet long, respectively.

The first pier, now under construction, and known as No. 2, is being built on what is known as the Cunard property, which was purchased by the Government some five years ago for $165,000 (£34,000). The contract to build this pier was secured by the Nova Scotia Construction Company, which has opened an office in this city, and the figure for the wharf portion and shed, without appointments, was $914,600 (£187,500).

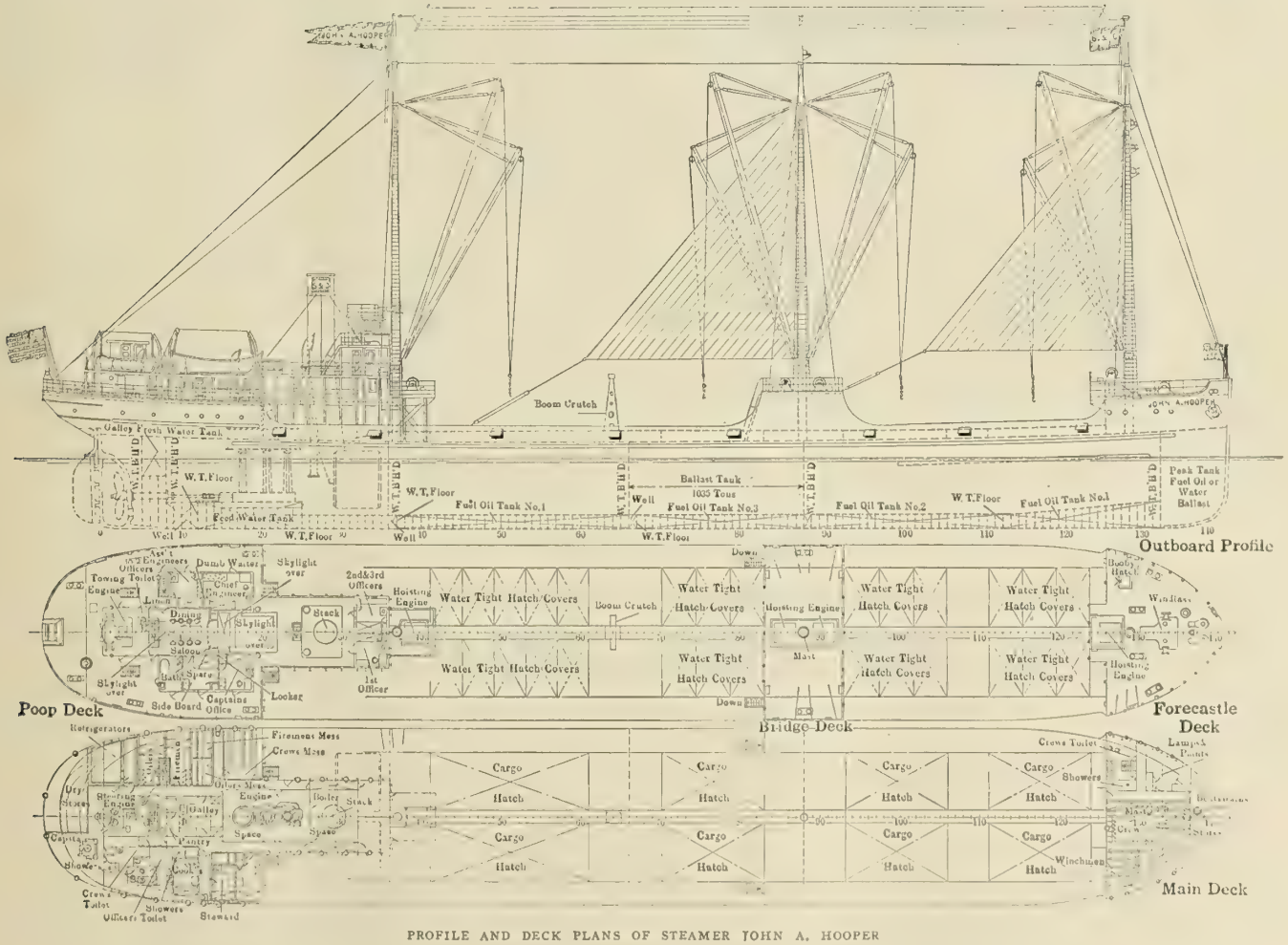
The contract calls for the clearing of the present site of the existing buildings, to deepen, if necessary, the basins on either side of the pier so as to give a depth of water of 34 feet, and the shed walls are to be of concrete with iron window and door frames—the doors being 16 feet high. There will be a depth of water of 65 feet at the head or water end of the pier.

This shed will contain two floors, the lower for freight pur-

* Secretary Board of Trade, Halifax, N. S.



STEAM LUMBER SCHOONER JOHN A. HOOPER



PROFILE AND DECK PLANS OF STEAMER JOHN A. HOOPER

poses, and will have two railway tracks in the center inside the shed and a track on either side. The freight platform will be 90 feet wide and the entire length of the shed—720 feet. On the upper floor of this shed will be offices in connection with the Immigration Department, also for the inspection of baggage, etc., by the customs officials; there will also be a restaurant, sleeping apartments for the officials, etc. The building will be fireproof and the appointments of the very best character. This pier is one of the largest of similar construction on the Atlantic seaboard.

Pier No. 4 is of similar construction, and will also be used for passenger and freight purposes; Pier No. 3 will be used entirely for freight purposes, and No. 5 was planned for the use of coastwise steamers, etc.

The plan also calls for the removal of the present local freight shed. This shed is of brick, with granite trimmings, and is 800 feet long by 110 wide, and for some years has been found altogether inadequate for what it is used. The purchase of the property on the opposite side of the street has been recommended and the erection of a local shed to be placed thereon. This will not only place the shed in a better position for local purposes but will give much needed yard room.

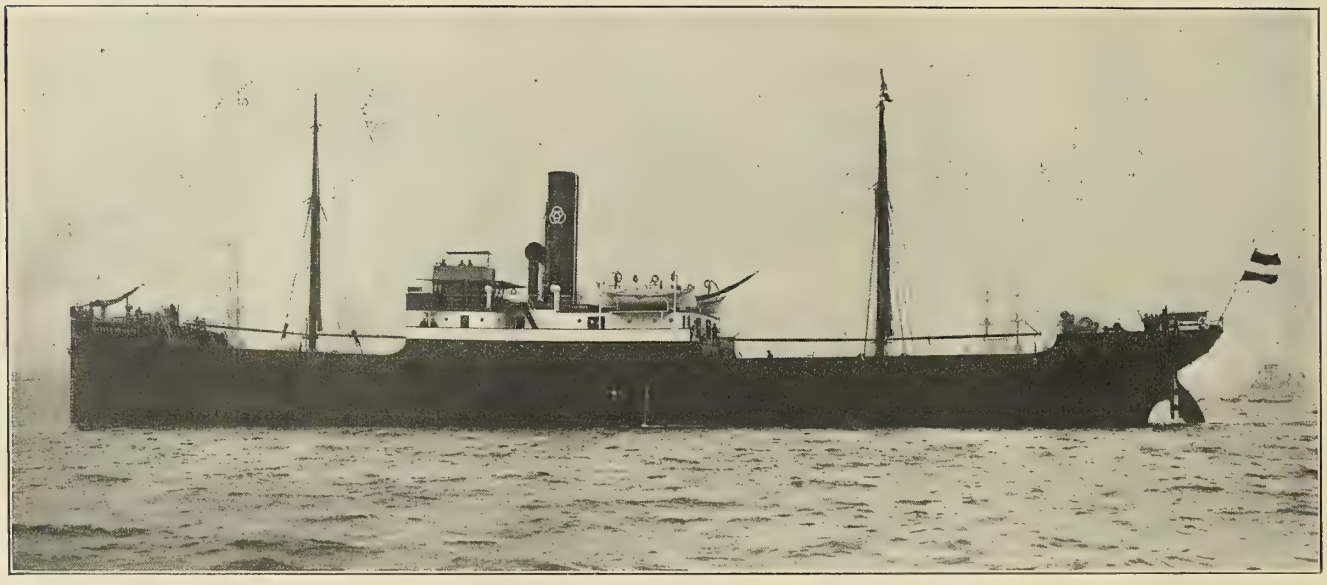
The building of the new pier does not in any way interfere with the present facilities, but to relieve the congestion of freight a shed is being erected on Pier 9 at Richmond, which is 650 feet long by 89 feet wide. The contract for the building of this shed was awarded Falconer & McDonald, of this city, and the figure was in the neighborhood of $30,000 (£6,150).

Although additional property was appropriated by the Government some three years ago at the terminal piers, which gave additional room for 800 cars, and the removal of the round-house and work shops from Richmond a year later gave additional room for 1,200 cars there, both these yards are at the present time found inadequate, and there is already a congestion, showing plainly the need of extending the facilities.

The import and export freight handled at the piers last winter was 100 percent more than the winter previous, and up to the present time it has been 25 percent in advance of last year. Among the shipping people there is a feeling that even when the present plan is completed that it will be only sufficient for present needs.

To give some idea of the construction of the new piers, a bulkhead is called for at the shore end, and the pier proper is built of concrete trestles, braced, and facings and deck. The bulkhead is built in cribs or blocks reaching up to about 2 feet above low water; above that level the crib work is built continuous and finished with a coping of two 12-inch square creosoted timbers laid side by side. The cribs are filled with stone, too, at least 15 feet high above the bottom, and above that to rail level with earth or other good filling. The pier itself is built of reinforced concrete piles, calculated to stand a load of from 85 to 90 tons on each pile, driven to rock, stayed as they are driven, and the braced tiles are molded on such a curve as to make a uniform stress throughout the cross-section of the pile under a compression of 80 tons on the pile sloping.

The comprehensive plan, when completed, will total upwards of $5,000,000 (£1,025,000) of an outlay.



GERMAN ORE STEAMER DR. ADOLF SCHMIDT, BUILT FOR MESSRS. FRIEDRICH KRUPP, A.-G.

Messrs. Krupp's New Ore Steamer

The ore steamer *Dr. Adolf Schmidt,* built at the Germania Shipyards to the order of Messrs. Friedrich Krupp A.-G., and which is named after a former director of that company, is a vessel of 3,650 tons capacity, destined for the journey to Messrs. Krupp's Spanish ore mines. Its dimensions are 286 feet 6 inches by 43 feet by 18 feet 8 inches. The engine has an output of 1,000 indicated horsepower, the speed of the vessel being 9.5 knots and the tonnage 2,246.8 British register tons.

The engine is a triple-expansion engine of 1,000 indicated horsepower, located amidships, its cylinder diameters being: High-pressure, 20 inches; intermediate, 24 inches; low-pressure, 5 inches, and the stroke 40 inches. Two cylindrical boilers, 10 feet 9½ inches in length and 13 feet 8½ inches in external diameter, as well as a small auxiliary boiler, 9 feet in length and 9 feet in external diameter, supply the steam required for this engine.

When traveling without load, the vessel can carry 946 tons water ballast in special tanks, warranting the seaworthiness required in this case. The two spacious cargo holds, each 92 feet in length, which can be subdivided by wooden bulkheads, are each controlled through two big hatchways, 23 and 19 feet in length, respectively, allowing the vessel to be filled with ore or unloaded in a very short time (four hours). Unloading is effected by means of four derricks fitted to two substantial hoists, and which are controlled by six steam capstans or else by means of grips or other mechanical hoisting devices.

Passenger Vessel for Great South Bay

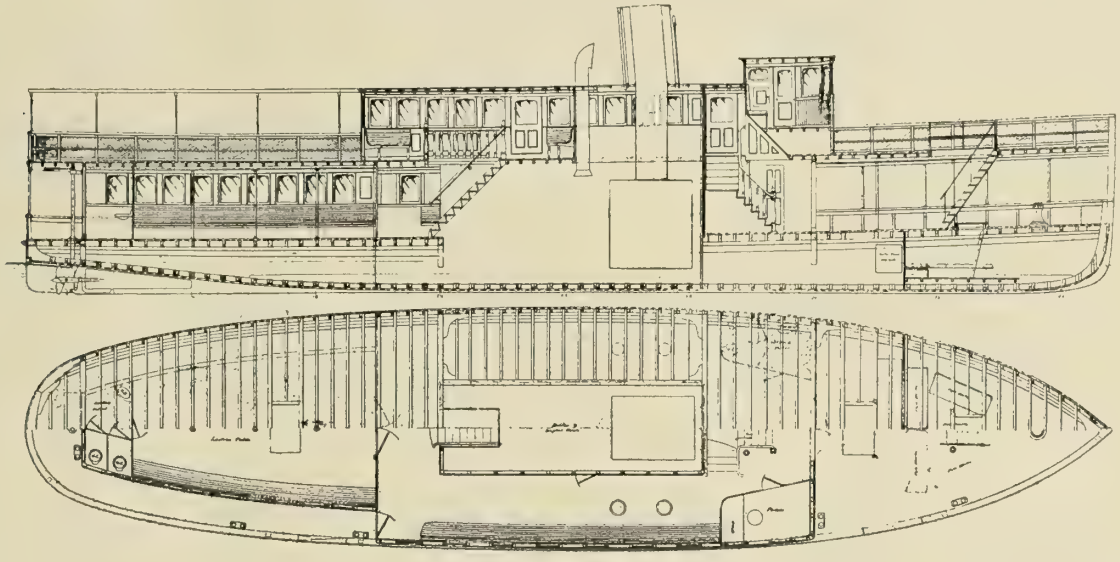
An interesting new passenger steamer is the twin-screw propeller *Patchogue,* built from designs and specifications and under the supervision of Cox & Stevens, naval architects, New York. The owners are the Patchogue & Water Island Navigation Company, of Patchogue, N. Y.

The principal dimensions of the vessel are:

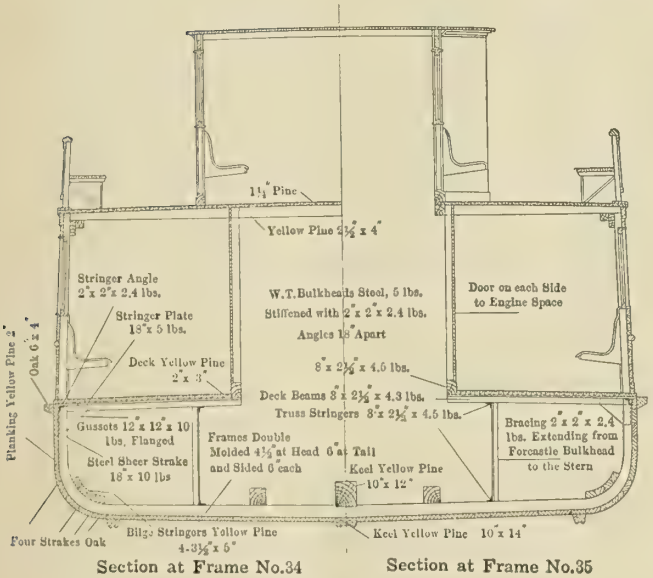
Length over all	105 feet.
Length on waterline	104 feet.
Beam	23 feet.
Draft	3 feet.

The machinery consists of two triple-expansion engines, 6 inches, 9¾ inches, 15½ inches by 9 inches stroke, placed amidships, supplied with steam by a Robert's boiler. Owing to the extremely limited draft and consequent small depth of hull, the architects were forced to give particular attention to rigidity in hull construction. A wooden hull was decided upon as being best suited for the purpose, but in order to take care of the strain on the structure a deep steel plate was worked between the planking and the frames, associated with a steel plate deck stringer under the deck, these plates being connected by a fore and aft stringer angle and heavy steel brackets at each beam, the beams also being of steel. This construction has provided for the maximum possible strain with a minimum of weight, and is associated with a longitudinal system of trussing of the hull, which does not in any way interfere with the operation of the machinery.

TWIN-SCREW, SHALLOW-DRAFT STEAMER PATCHOGUE



PROFILE AND DECK PLAN


1¼" Pine
Yellow Pine 4½" x 4"
Stringer Angle 2" x 2" x 2.4 lbs.
Stringer Plate 18" x 5 lbs.
W.T. Bulkheads Steel, 5 lbs.
Stiffened with 2" x 2" x 2.4 lbs.
Angles 18" Apart
Door on each Side to Engine Space
Deck Yellow Pine 2" x 3"
8" x 2½" x 4.5 lbs.
Deck Beams 8" x 2½" x 4.3 lbs.
Truss Stringers 8" x 2½" x 4.5 lbs.
Planking Yellow Pine 2"
Oak 6" x 4"
Gussets 12" x 12" x 10 lbs. Flanged
Steel Sheer Strake 18" x 10 lbs
Frames Double Molded 4½" at Head 6" at Tail and Sided 6" each
Keel Yellow Pine 10" x 12"
Bracing 2" x 2" x 2.4 lbs. Extending from Forecastle Bulkhead to the Stern
Four Strakes Oak
Bilge Stringers Yellow Pine 4-3½" x 5"
Keel Yellow Pine 10" x 14"
Section at Frame No.34
Section at Frame No.35

MIDSHIP SECTION

The vessel has no stateroom accommodation for passengers, as she is for day service, but has an immense amount of deck room covered with awnings and unusually comfortable saloons and toilet rooms, all well equipped and lighted by electricity. The pilot house contains necessary accommodation for the crew. A great deal of care has been given in this design to produce a vessel that will be attractive in appearance, comfortable and economical to run.

The placing of this vessel on the South Bay is to a certain extent an experiment, and for that reason those interested wished to make the proposition as attractive as possible to their prospective clients, an end which they have ably secured. The *Patchogue* has made a good showing during her first season, having carried a large number of passengers and built up an increasing business. When certain proposed trolley connections across Long Island are completed, this vessel will take passengers to the ocean who a few hours before have been in Connecticut, having crossed the Sound on a ferry and Long Island by trolley, thus making a delightful outing.

In her trip to Patchogue from City Island this vessel naturally had to make quite an extended trip in the ocean, and although the weather was quite rough she came through comfortably and without damage. The speed is very satisfactory, being in excess of 12 miles per hour.

World's Progress in Shipbuilding in 1912

The remarkable activity in shipbuilding throughout the world recorded a year ago was in no wise abated in 1912. From statistics compiled by the *Glasgow Herald* the total tonnage of vessels launched throughout the world during 1912 was 5.66 percent greater than in 1911, thereby establishing a record never before approached. In the United Kingdom there was an increase of .24 percent; in Germany an increase of 32 percent; in the United States an increase of 19.8 percent, and in Holland an increase of 44.6 percent. The returns from France indicate a slight decrease and in Italy a marked decrease. Figures from some of the other less important maritime nations show, in general, remarkable increases in tonnage launched during the past year, and while these figures may be somewhat incomplete yet they tend to show the general favorable trend of the world-wide activity. Quoting from the *Glasgow Herald* the tonnage and indicated horsepower of vessels launched by the different countries during 1912 and 1911 are as follows:

	1912.		1911.		Increased Tonnage Built.
	Tons.	I. H. P.	Tons.	I. H. P.	Percent.
England	1,232,390	1,263,086	1,221,948	1,139,527	.86
Scotland	688,188	914,741	671,624	837,668	2.5
Ireland	164,748	93,450	186,825	150,116	—11.9
United Kingdom totals	2,085,326	2,271,277	2,080,397	2,127,311	+.24
Colonial	36,578	17,922	29,249	12,875	25.
Germany	530,312	646,025	401,881	666,785	32.
United States	321,592	324,208	268,561	257,825	19.8
Holland	258,263	112,859	178,618	101,730	44.6
France	177,883	254,595	184,411	324,205	—3.5
Japan	89,925	180,851	84,462	164,375	6.5
Austria-Hungary	83,192	89,910	68,390	48,485	21.8
Norway	53,256	58,273	38,222	41,004	39.4
Italy	35,617	201,865	86,814	148,150	—59.
Denmark	27,622	18,605	18,961	18,040	45.6
Belgium	21,329	9,215	12,489	1,798	70.7
Spain	20,372	37,750	6,760	10,800	202.
China	13,057	8,260	4,222	3,920	209.
Sweden	12,286	10,680	9,734	16,931	26.2
Russia	3,604	4,510	94,905	169,215	—91.3
Grand total	3,770,214	4,246,805	3,568,076	4,103,449	5.66

A comparison of the work done in the principal shipbuilding centers of the world during the past year is shown by the following table:

PRINCIPAL DISTRICTS

	Vessels.	Tons.	I. H. P.
The Clyde	389	640,529	873,326
Germany	408	530,312	646,025
The Tyne	97	388,376	464,855
United States	196	321,592	324,208
The Wear	82	309,934	191,806
Tees and Hartlepools	100	261,888	182,210

The largest tonnage launched by any one concern during the year was by Swan, Hunter & Wigham Richardson, a firm which has in recent years always ranked as one of the leading shipbuilders in the world, being outdistanced last year by only one concern—Harland & Wolff—which this year has fallen to sixth place.

LEADING SHIPBUILDERS

	Vessels.	Tons.
Swan, Hunter & Wigham Richardson	21	121,281
The Vulcan Company (2 yards)	11	96,639
Workman, Clark & Company	10	85,391
William Doxford & Sons	18	80,995
William Gray & Company	20	79,841
Harland & Wolff	7	77,591

The largest ship launched during the year was the Hamburg-American Company's monster liner *Imperator*, built by the Vulcan Company in their new yard at Hamburg, and which is a quadruple screw, turbine-driven ship of 52,000 tons. The second largest vessel launched was the White Star liner *Ceramic*, building at the Harland & Wolff yards at Belfast. She is a triple-screw vessel of 18,500 tons, driven by combination reciprocating and turbine engines. The sister ships, *Empress of Russia* and *Empress of Asia*, of 16,850 tons each, building by the Fairfield Company, are the next largest vessels launched. They are also turbine-driven ships with quadruple screws, and are destined for the Canadian Pacific Railway Company's Pacific service. While the bulk of shipbuilding during the year was of comparatively small tonnage, nevertheless the twin-screw steamer *Nestor* of 14,500 tons, under construction at the yards of Workman, Clark & Company, and the triple-screw steamer *Niagara*, of 13,342 tons, fitted with combination reciprocating and turbine machinery, building at Clydebank by John Brown & Company, should be classed among the leading vessels.

A better comprehension of the conditions existing in United States shipyards may be obtained by referring to the reports of the Bureau of Navigation of the Department of Commerce and Labor for the calendar year ended Dec. 31, 1912, which cover the mechant tonnage completed and registered. According to these reports, 1,727 sailing, steam and unrigged vessels of 292,477 gross tons were built and officially numbered during the year. During the corresponding year ended Dec. 31, 1911, 1,592 sailing, steam and unrigged vessels of 309,640 gross tons were built and officially numbered, indicating a slight decrease in merchant tonnage. Including the warship tonnage, however, as is done in the reports compiled by the *Glasgow Herald*, which take into account the vessels launched and not those completed, the total amount of work done in the United States during the year represents a satisfactory increase.

Referring to the Bureau of Navigation reports again, the total tonnage of all classes of merchant vessels built on the Atlantic and Gulf coasts of the United States was 171,494, or about 59 percent of the total gross tonnage. About 26 percent was built on the Great Lakes and 13 percent on the Pacific Coast, the remaining tonnage falling to the Western rivers and Porto Rico. Conditions during the last year were, therefore, somewhat the same as a year ago, when the Atlantic and Gulf coast yards produced about 65 percent of the total merchant tonnage, and the Great Lakes yards about 22 percent. Of the total number of ships building in the United States during 1912, 105 were steel steamships aggregating 155,743 gross tons, or about 53 percent of the total tonnage built.

The greatest volume of work in an American shipyard was turned out by the Newport News Shipbuilding & Dry Dock Company, where twelve vessels, aggregating 61,242 gross tons and 62,100 indicated horsepower, were launched. The merchant work credited to this yard includes the steamships *Evelyn* and *Carolyn*, both of 3,141 tons; the Clyde Line steamer *Lenape*, 5,170 tons; the *Adeline Smith*, of 2,168 tons, and the *Peter H. Crowell*, 3,100 tons, besides car floats, tugs and smaller vessels. For Government work the Newport News yard has launched the battleship *Texas*, 28,367 tons; the destroyer *Fanning*, 755 tons; the submarine *Tuna*, 500 tons; the revenue cutters *Miami* and *Unalga*, of 750 tons each, and the naval collier *Proteus* of 12,000 tons. The Newport News yard also has under construction the collier *Nereus* and an ammunition lighter for the United States Government, a cargo and passenger steamer for the New York & Porto Rico Steamship Company, an oil steamer of 5,100 gross tons for the Texas

Steamship Company, and an oil carrier of the same tonnage for the Southern Pacific Company, besides two large passenger and cargo steamers for the Matson Navigation Company, San Francisco. A smaller steamer of about 3,000 gross tons is also in hand.

The American Shipbuilding Company, the Maryland Steel Company and the New York Shipbuilding Company each turned out over 30,000 tons; the American Shipbuilding Company, the largest Lake shipbuilding concern, being credited with thirteen vessels, aggregating 38,015 tons, including the steamers *City of Grand Rapids, See* and *Bee*, four large Standard Oil barges, four medium-sized freighters and other smaller ships. At the Maryland Steel Company's yard two of the American-Hawaiian steamships, the *Minnesotan* and *Dakotan*, were completed, besides two naval colliers, the *Orion* and *Jason*. This yard has in hand six other American-Hawaiian steamships. At the New York Shipbuilding Company the naval work includes the destroyer *Jarvis*, two tugs, a Chinese cruiser and an Argentine battleship, while for merchant work they have completed three large oil steamers, two merchant colliers and a large river steamer, besides smaller vessels. The naval work in hand at this yard includes the battleship *Oklahoma* of 27,000 tons and two destroyers. The merchant work in hand includes three oil tankers for the Standard Oil Company, an oil tanker for the Gulf Refining Company, the steamship *Congress* for the Pacific Coast Steamship Company, and a steel steamship for the Old Dominion Steamship Company. Work in hand at the Fore River Shipbuilding Company, Quincy, Mass., includes the Standard Oil tanker *Richmond*, with a capacity of 1,500,000 gallons, three steam trawlers, besides a large amount of government work, which includes the battleship *Nevada*, two destroyers, a submarine tender, several submarine boats and the Argentine battleship *Rivadavia*. The Fore River Company completed in 1912 the destroyer *Henley* and three large freight steamers, two of over 4,000 tons. The William Cramp & Sons Ship & Engine Building Company, has been occupied chiefly with Government work. Seven destroyers are now in hand and a submarine and the gunboat *Sacramento*. Merchant work in this yard includes a 10,000-ton steamship for W. R. Grace & Company. At Bath, Me., the Bath Iron Works has under construction three destroyers and a small passenger steamer for the Maine Central Railroad. The Harlan & Hollingsworth Corporation, Wilmington, Del., which is devoted exclusively to merchant work, has in hand two passenger steamers of 4,000 tons each and a steel ferryboat, besides an order for car floats from the New Jersey Central Railroad.

The volume of shipping on the Pacific Coast is not large, but there is considerable variety in the types of ships under construction. At the Union Iron Works, San Francisco, three steel lumber schooners are in hand, besides a Standard Oil barge and four submarines. A 12,000-ton floating drydock for the company's own use is under construction by the Seattle Construction & Dry Dock Company, Seattle. For Government work this yard has two submarine boats for the Chilian Government and two for the United States Government. The merchant work includes two passenger steamers for the Inland Navigation Company, a large steam yacht and a suction dredge of nearly 2,000 tons. Another yard on the Pacific Coast where considerable work is in hand is the Craig Shipbuilding Company, Long Beach, Cal., where four medium-sized steamships are being built and also a large steel dredge.

Only two navy yards—the New York and Mare Island navy yards—are equipped for building new ships. At the New York yard the battleship *New York* was recently launched. At the Mare Island navy yard the naval collier *Jupiter*, to be fitted with turbine engines and electric transmission, is nearing completion, while two river gunboats have been laid down.

On the Great Lakes thirty-five vessels were launched during 1912, and fifty-two vessels are now under construction for 1913 delivery. Nine freight steamers of the 1912 production were for coast service. The construction of large bulk freighters has decreased rapidly during the last three years, but as there are excellent prospects for a large movement of ore in the coming year it is quite probable that orders for such vessels will soon be forthcoming. The types of vessels built on the Lakes during the past year have varied more than usual, as the yards have been freer to take on special contracts.

DISTRIBUTION OF SHIPBUILDING IN THE UNITED KINGDOM

	1912.			1911.		
	Ves.	Tons.	I. H. P.	Ves.	Tons.	I. H. P.
The Clyde	389	640,529	378,326	413	630,583	768,889
The Forth	32	19,054	7,915	31	11,319	9,355
The Tay	28	17,388	10,400	31	17,303	14,770
The Dee, etc	71	11,217	18,100	82	12,419	23,614
The Tyne	97	388,376	464,855	126	418,325	421,060
The Wear	82	309,934	191,806	86	286,834	193,343
Tees and Hartlep'ls	100	261,888	182,210	134	279,245	160,640
Mersey-Solway	128	139,601	243,480	128	84,085	245,649
Humber	131	48,495	62,970	117	44,966	55,770
The Thames	120	14,319	16,860	167	38,504	72,751
English Channel	130	11,931	101,635	97	8,829	90,974
Bristol Channel	39	3,761	170	36	3,050	985
Dockyards	4	54,085	.....	7	59,260	.....

Nearly all of the shipbuilding districts in the United Kingdom benefited by the widespread activity in the production of tonnage for the year 1912. Only the Tyne, the Dee, the Tees and Hartlepools and the Thames districts showed any decrease, and with the exception of the Thames these decreases were very slight. The Clyde shipyards head the list in the volume of tonnage produced, as has been the case in recent years. In spite of the remarkable increase in shipbuilding which was experienced a year ago the demand for construction in this district has not in any way fallen off; on the other hand, the record figures produced this year apparently represent the legitimate results of the natural growth of shipping. The year has undoubtedly been the best and steadiest year ever experienced from a business point of view, and the prospects for the continuance of this prosperity in the immediate future are excellent. Almost every conceivable type of vessel was built on the Clyde during the year, with screw steamers of moderate size dominating. Outside of the Cunard liner *Aquitania*, no unusually large ships are in hand in this district. Considerable attention has been given to motor vessels, and while there has been an apparent falling off in Government work, nevertheless a vast amount of marine machinery for Government vessels has been turned out. The total indicated horsepower of marine machinery produced on the Clyde during the year was over 878,000, or about two-thirds of all the horsepower produced in the English engine building works in 1912. John Brown & Company had not only the biggest output on the Clyde, amounting to 178,500 indicated horsepower, but this is also the greatest amount of work ever turned out by a single concern in one year. The next highest record in this respect was made by the Vulcan Company in Germany last year, where 166,250 indicated horsepower was produced.

The returns from the English shipyards resemble very closely the figures turned in at the end of 1911, the bulk of the tonnage, as usual, being produced on the Northeast coast. Although there was a slight decrease in the Tyne district in 1912, a large amount of turbine and engine work was produced, and the prospects indicate that a large share of Government engine work will fall to this district. In the Wear district the prospects are also good. Swan, Hunter & Wigham Richardson have now ready a new yard for the construction of small vessels. In the Thames district the closing of the Thames Iron Works marks another period of decay in the shipbuilding industry for this district.

First Long Voyage of Motor Ship Eavestone

It is quite fitting, as one of our readers has reminded us, that one of the first ocean-going motor-driven cargo ships should make her advent in United States ports at Savannah, Ga., since it was from this port, nearly a hundred years ago, that the little steamship *Savannah,* of 250 tons, sailed to make the first voyage of a steamship across the Atlantic Ocean. The *Savannah's* voyage from Savannah to Liverpool took twenty-five days, and at that time it was conceived hardly possible that a ship propelled by a steam engine could be built that could carry enough coal to propel her across the ocean, to say nothing of carrying freight. Now almost a century later there has come into the same port a type of ship which marks another epoch in ocean transportation, as she is propelled by an internal combustion engine and carries in her double bottom sufficient fuel to carry the ship practically around the world without reloading, and, at the same time, carries a cargo equal to that carried in her sister steamships.

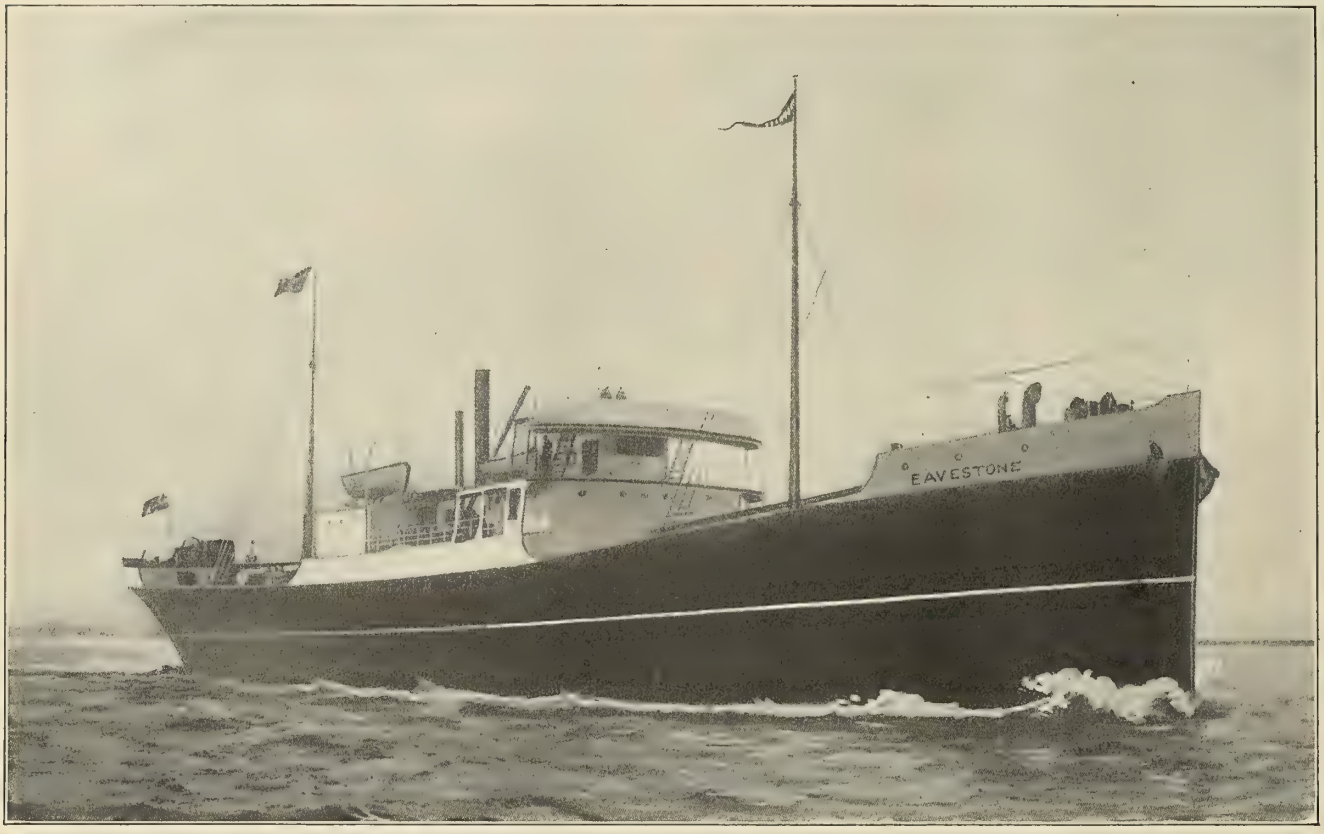


FIG. 1.—MOTOR SHIP EAVESTONE FITTED WITH 1,000 HORSEPOWER CARELS DIESEL ENGINE

The arrival of the motor ship *Eavestone* has, therefore, aroused considerable interest among naval architects, shipbuilders and marine engineers. The vessel itself is a single screw ship displacing 4,500 tons, with a length of 276 feet and a beam of 40 feet 6 inches. She is equipped with a 1,000 horsepower Carels-Diesel engine designed to give the ship a speed of 9½ knots. The hull was built by Messrs. Sir Raylton Dixon & Co., Middlesbrough, and the engines by Messrs. Richardsons Westgarth & Co., Ltd., Middlesbrough, in conjunction with Messrs. Carels Bros. Ltd., Ghent, Belgium. The vessel forms one of the large fleet of Messrs. Furness, Withy & Co., and as she is the first large British-built and British-owned Diesel-engined motor ship, the results of her first long voyage across the Atlantic have been awaited with interest.

The first trip which the ship made was from West Hartlepool to Antwerp and return. Then she sailed for the Baltic Sea with a cargo of coal, returning with a cargo of lumber. Starting on her first long voyage from West Hartlepool, she carried a cargo of coal to Barcelona, Spain. From Barcelona to Pomaron, Portugal, she ran light. At Pomaron she took on a full cargo of Pyrites ore and sailed for Savannah, Ga. This latter voyage covered a distance of 3,701 nautical miles and was completed in 18 days 18 hours. The total oil fuel consumed for the passage was 73 tons 10 cwt., the average daily consumption being 3 tons 18 cwt., making an average fuel consumption of .46 pound per shaft horsepower hour.

After loading a cargo at Savannah, the ship sailed for Norfolk, Va., to take on a cargo of fuel oil. A speed of 9½ knots was obtained on this trip, the engine developing 1,000 shaft horsepower at 92 revolutions per minute. After taking on 165 tons of fuel oil, which was pumped into her double bottom, she sailed from Norfolk, January 7, for Rotterdam, London and West Hartlepool, when she will return again over the same course via Barcelona, Pomaron and Savannah back to Norfolk, completing the entire voyage of over 8,000 miles without taking on any additional fuel.

The economy of this type of engine seems quite well established from the record of fuel consumption on this long voyage, and the reliability of the engine is also evidenced by the fact that the voyage was made without a single stop, the engine meeting every requirement of continued service. After the ship had finished her voyage, however, trouble was experienced by the cracking of a cylinder head and the cracking of a piston. The cylinder heads in this engine were made of cast steel to meet Lloyd's requirements, although we understand it had been the custom of the Carels Company to use in all their Diesel engines a special grade of cast iron

for the cylinder heads. Since this experience with the cast steel heads in the *Eavestone's* engine, it is understood that the cast steel heads will hereafter be replaced by the special grade of cast iron advocated by the builders and which has given satisfactory results in their stationary engines in service for a number of years.

The cause of the cracking of the piston is attributed partly to defective water circulation through the piston, a fault which it seems could easily be avoided by careful supervision when the engine is starting up, as it should be quite possible to ascertain the temperature of the circulating water and thus determine whether all parts are being properly cooled. As the circulating pumps are driven off the main engine, and the water is taken first from the main air compressor into the pistons, then to the crosshead guides and main bearings, thence flowing to a tank in the bilges, circulation, of course, is not established until the main engine has started. Perhaps trouble from this source might be avoided if independent circulating pumps were used, so that the water circulation could be established before any attempt was made to start the engine, since the engine itself operates on air for only a very few revolutions, and begins to operate on oil almost as soon as it is started.

A general description of the *Eavestone's* engine was published in our October, 1912, issue, but a more detailed description of the valve gear arrangements is now possible after

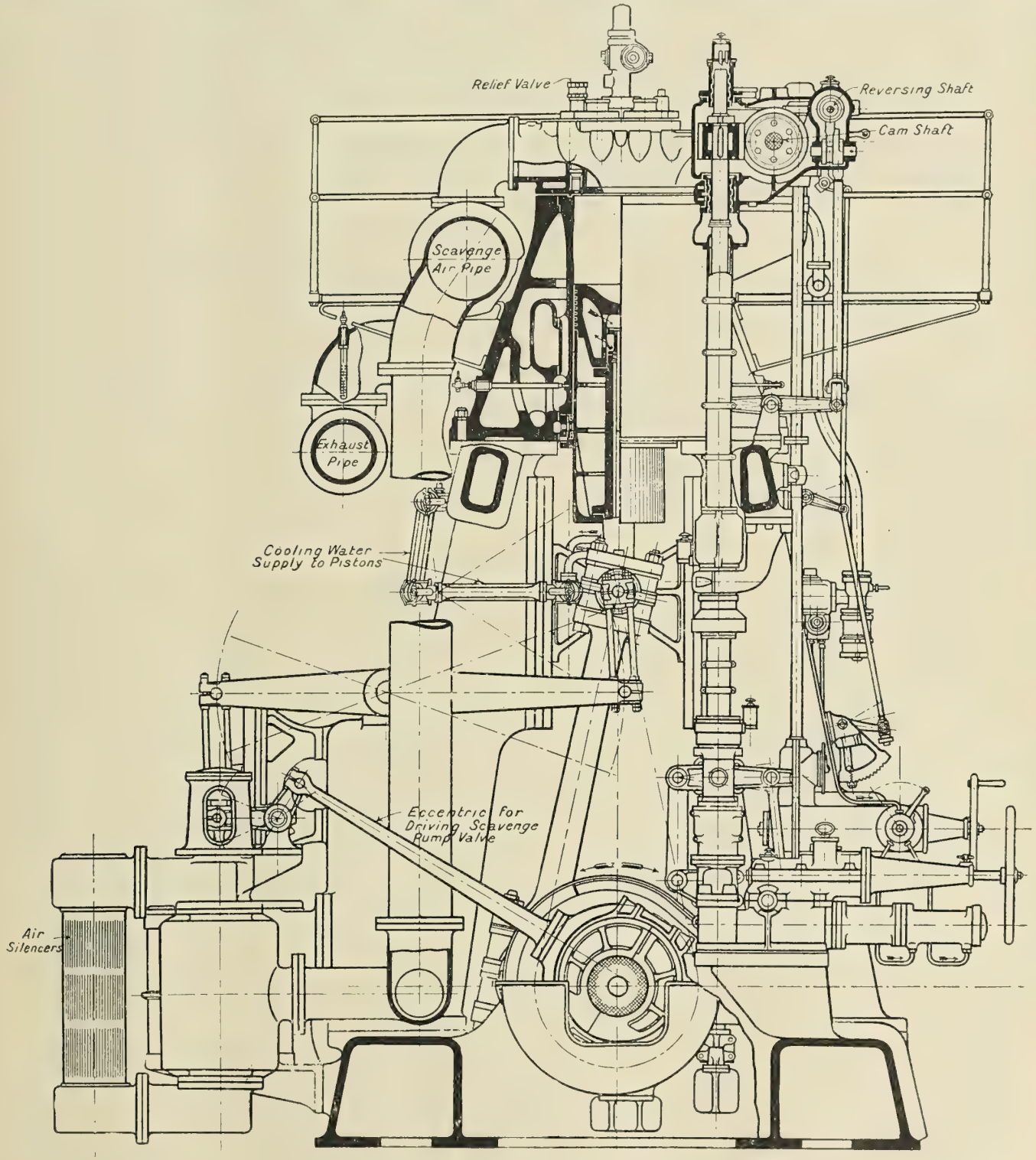


FIG. 2.—SECTIONAL VIEW OF EAVESTONE'S ENGINE

(Engraving Reproduced from *The Engineer*)

observation of the engine in service. The engine is a four-cylinder two-cycle Carels engine with cylinders 20.1 inches diameter and 36.22 inches stroke. Its simplicity in design permits of easy access to all working parts, and its strong resemblance in external appearance to the ordinary triple-expansion steam engine undoubtedly goes far to overcoming the prejudice of marine engineers towards the advent of internal-combustion engines on board ship. Besides the construction of the rigid bedplate, heavy box columns, connecting rods, crossheads and double guides, which are practically identical with steam practice, the similarity between the Carels engine and the steam engine is carried out still further by the fact that its

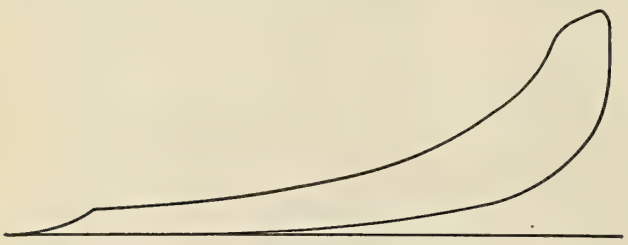


FIG. 3.—INDICATOR CARD FROM CYLINDER NO. 3 OF EAVESTONE ENGINE. COMPRESSION 460 POUNDS PER SQUARE INCH

circulating water pump, bilge pump, fuel pump and air pumps are all actuated by levers from the main engine's crossheads.

The construction of the cylinders, cylinder heads and pistons will be understood from the sectional drawing (Fig. 2) which is reproduced from *The Engineer*. The cylinder has a separate liner inserted with the exhaust ports extending around its periphery at the lower end. An exhaust belt of ample area extends around the cylinder in the water space through which the exhaust gases pass to the main exhaust pipe. The pistons are built in two sections, the top piece is carried by a shoulder on the piston rod, and the bottom piece, which serves to cover the exhaust ports while the piston is at the top of its stroke, is carried at its lower end by another shoulder on the piston rod. A stuffing box at the lower end of the liner serves to prevent leakage of any exhaust gas past the piston into the engine room.

All of the valves are placed in the cylinder heads. There are four scavenging valves, a fuel oil injection valve, an air starting valve and a relief valve in the head of each cylinder. All of the valves are operated through levers actuated by cams carried on a shaft which is supported by bearings on the cylinder jackets. The cam shaft itself is actuated by means of a vertical shaft and spiral gears at the center of the engine connecting the cam shaft to the crank shaft. A maneuvering shaft, which runs alongside the cam shaft, serves to operate the rollers of the valve levers, so that they are brought into contact with the proper cams for running the engine either ahead or astern.

The valve gear appears at first sight to be complicated, yet when seen in practice the operation of the gear proves quite simple. All of the moving parts have a comparatively slight motion, and the possibility for any part failing to perform its function is very remote. Four scavenging valves in each cylinder, for instance, are operated by two valve levers, for each of which there is a single cam, the relation of the movement of these cams to the crank shaft being changed for ahead and astern rotation by the rotation of the cam shaft itself to an angle of about 30 degrees by lengthening through a servo motor the vertical shaft connecting the crank and cam shafts. For both the fuel injection and the air starting valves there are two cams for each valve, and for the operation of these valves the maneuvering shaft comes into play. The rollers on the valve levers do not come in contact with these cams, but are held well above them, and an intermediate or roller-raising lever is inserted which in turn is controlled from the maneuvering shaft. The maneuvering shaft is moved longitudinally, and the intermediate fuel injection and air-starting levers are brought into line with the fuel or air-starting cams for either ahead or astern motion. Rotation of the maneuvering shaft causes the intermediate levers to descend upon the proper cam and still further rotation of the maneuvering shaft with its cams forces a wedge piece through a roller and spindle, establishing or withdrawing direct contact from the main cam shaft to the valve levers, as may be required when the engine is being operated on either air or oil.

This valve mechanism, especially the wedging action whereby the starting air is gradually cut out and the fuel oil gradually cut in in the different cylinders of the engine, is an ingenious arrangement and one which is always definite in its action, resulting not only in smooth running of the engine with the avoidance of shocks when starting or reversing, but also reducing the human factor in handling the engine to a minimum; in fact, the entire control of the engine is by means of one wheel and two levers, one lever controlling the fuel and the other the reverse changes. It was demonstrated that the engine could be operated from full speed ahead to practically one-third speed, or, to be exact, from 92 revolutions per minute to 35 revolutions per minute, by a slight movement of the lever which controls the fuel pumps. Reversing from full speed ahead to full speed astern takes less than eight seconds, and the speed of the engine can be brought down to a minimum of 35 revolutions per minute. The engine runs with practically no vibration and with very little noise. When the engine has been lying idle for some time it is occasionally found necessary to resort to a fuel with a lower flash point, such as kerosene (paraffin) when starting. This was found necessary while the ship was in Norfolk, when it was thought that full compression was not obtained on account of the wearing of the main bearings after the long voyage across the Atlantic. As soon as the engine was started, however, no further difficulty was found in firing the heavy fuel oil. An indicator card is shown in Fig. 3, taken when the engine was running at 92 revolutions per minute with a compression pressure of 460 pounds per square inch.

It will be recalled from the article published in our issue of October, 1912, that the main auxiliaries were driven off the main engine, the only independent auxiliaries operated by steam from the coal-fired donkey boilers were the winches, steering gear, donkey pump, condenser circulating pump, steam ballast pump, an evaporator and a spare air compressor of 60 horsepower. While running at sea the donkey boilers are shut down except for driving the generator or for steam heat. The steering gear is then run by compressed air at 35 pounds pressure, supplied by the main compressor to a storage tank in 'tween decks. The steam circulating pump for the condenser is also shut down and circulating water from the main engine pump is used. Ordinarily the main air compressor, which in this case is a multiple stage Reavell reversible compressor coupled directly to the main engine, is designed to deliver more air than required for fuel injection, so as to maintain sufficient pressure in the receivers to allow maneuvering without starting up the auxiliary steam-driven compressor. On long voyages, where the main compressor is in operation all the time, this would mean a waste, but here economical use is made of the excess air in the steering engine without effecting the results attained by the main engine.

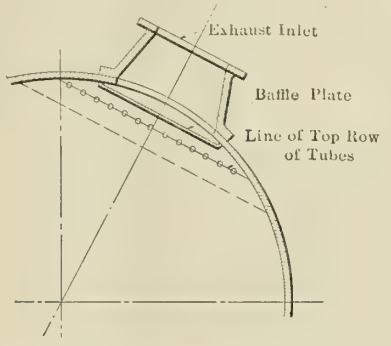
DERRICK-WRECKING STEAMER MAUCH CHUNK.—The Harlan & Hollingsworth Corporation, Wilmington, Del., recently launched the derrick-wrecking steamer *Mauch Chunk*, a steel vessel 118 feet long by 31 feet beam by 12 feet 9 inches depth, which that company is building for the Central Railroad of New Jersey.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Condenser Trouble

Some time ago a certain paddle steamer gave great trouble with her condenser tubes. The boat in question had been but recently launched and was fitted with an ordinary cylindrical surface condenser. After about three weeks' running the trouble began to manifest itself, and thereafter continued at regular intervals of about ten days, when a number varying between two and twenty-two tubes had to be renewed. Naturally, an inquiry was set on foot and the manufacturers had to supply an entirely new set of tubes. This procedure, however, did not abate the trouble one jot. As the condenser had by this time been inspected for leaks, a fairly large number of times it was noted that the faulty tubes were invariably



SECTION OF CONDENSER, SHOWING LOCATION OF TUBES

in the top three or four rows, and the expedient was resorted to of replacing these tubes with mild steel rods. After this had been accomplished the trouble ceased, hence one would infer that the cause of the evil was due to having the top row of tubes too near the baffle plate, as indicated in the accompanying sketch (not to scale). Had the top row of tubes originally been kept, say, six inches lower down, as indicated by the dotted line, in all probability the trouble would have been avoided. Naturally the substitution of the steel rods brings about a slight decrease in efficiency of the condenser, but it more than balances the money spent on renewing tubes. The above anecdote shows the necessity of careful design of the condensers. "ISON."

A Neglected Sea Danger

Since the *Titanic* disaster the question of safety at sea has been one of the leading topics of discussion in the marine circles of almost every nation. While attention is thus attracted to the overcoming of dangers at sea it should be remembered that besides collisions and stranding there is another equally formidable enemy to be coped with—i. e., the danger of fire. In expert circles the vexed question is asked as to whether the favorable opportunity of the international discussions in regard to the increase of security at sea will not also allow the consideration of the question: "To what extent can the danger from fire on board ship be limited?"

The building requirements of the German Lloyd Company, and accordingly of the whole of the sea-trading industry, in connection with the means for the prevention of the spread of fire on board ship, are limited to the provision that ships over 100 meters in length should be provided with partition walls at distances not exceeding 40 meters. As, however, it is not stipulated that these partitions should be rendered fireproof, they are, in fact, not actual "fireproof partitions," but mere divisions which can prevent the spread of the smoke until such time as they themselves become ignited. They therefore only deserve to be called "smoke partitions." If one compares the police building regulations for public and private buildings on land with those for the building of ships, the insufficiency of the latter will immediately be recognized.

In order to afford effective security against the fatal spread of a fire on board ship it is necessary that the ship be divided into several fireproof compartments separated from one another. With this arrangement the fire would remain in *one* part, passengers and crew would find protection in another part, and the ship would be guarded against total destruction. There are also a few very important parts of the ship which require to be protected by fireproof walls and decks; these are the postal rooms, bullion and cash rooms and the wireless telegraph room.

The system already existing for the watertight division of rooms may also be adopted for the division of fireproof compartments, as a few of them can be rendered fireproof. As ships are now constructed, a fire could in a very short space of time spread over the whole ship, and so quickly that there might not even be time for the passengers to escape with the boats.

If anyone had undertaken before the *Titanic* tragedy to suggest that the unsinkable qualities of ships should be improved, and that boats should be provided for all on board, he would have preached to deaf ears. No one would have taken his proposal seriously and deliberate shrugs of the shoulder would have been the answer. After the sinking of that ship all the world regards these securities as a matter of course.

May we never have to wait for a fatal fire on board ship before we realize that ships must be rendered not only unsinkable but also fireproof. Compared to the terrible results of a catastrophe through fire on board a passanger steamer, even the awful calamity of the sinking of the *Titanic* might appear insignificant. D. AUGER.

"When a Dutchman is Not a Dutchman"

No doubt there is a great deal of unnecessary, and, in the end, unsatisfactory work done in connecting or making up that part of a ship's construction which involves the use of steel castings, such as stern posts, hawse pipes and other bulky parts. The fault, however, does not always lie in the casting, but in the lack of foresight in the design.

There is bound to be unavoidable variation in the structure of a ship, and steel castings are not all uniform. To overcome this uncertainty in general practice, heavy chipping surfaces are provided, which are in turn chipped off in the field with hand air tools. Those who are familiar with this class of work (and it is common in all shipyards) will appreciate the slow, laborious rule-of-thumb methods that have to be resorted to before the scarph or lap is ready for bolting or riveting. In many cases the "spare" to be chipped off on both joining surfaces (whose area is often 4 to 6 square feet) will be a depth of solid steel 1½ to 2 or 3 inches. Now to chip this off by eye with hand air tools, and often on unsteady platforms high above the ground, is a slow and expensive operation; so is the work of the fitters with the assistance

of the rigging gang, who must raise and lower these heavy parts until a satisfactory fit is finally secured.

A metal to metal fit is, of course, required, and a metal to metal fit is secured, in spots at least, as chipping, skillful though many of these workmen are, is far from the machined surface fit that is really aimed at in the design. A stopwater of variable thiskness, well soaked with thick red lead, is the "finishing touch," as the casting is pulled to its line and riveted up. Seeming impossibilities are overcome daily in shipyards as a matter of course, but they are expensive, and when finished are not what the design intended. This is not the workman's fault and not the fault of the casting. The trouble lies in the design.

To eliminate these conditions where possible is what should be done. Our hull men can learn a lesson now and then from their engineering brothers, and one in particular on this class of work. Where the engineer recognizes that a fit between two members is next to impossible, he wastes no valuable time fighting the inevitable, but allows a certain space to exist and goes ahead working above and below this imaginary line, established on a good common sense basis, and finishes his work accordingly. When the assembling comes, a finished liner of proper size and material is inserted, and the chipping, fitting and numerous other operations and delays never occur, due to the very reasonable idea that overcoming near impossibilities may be possible, but are not efficient or economical.

Sectional parts of cast steel structure can be treated in a similar manner in many cases (where it is not generally done) with good results.

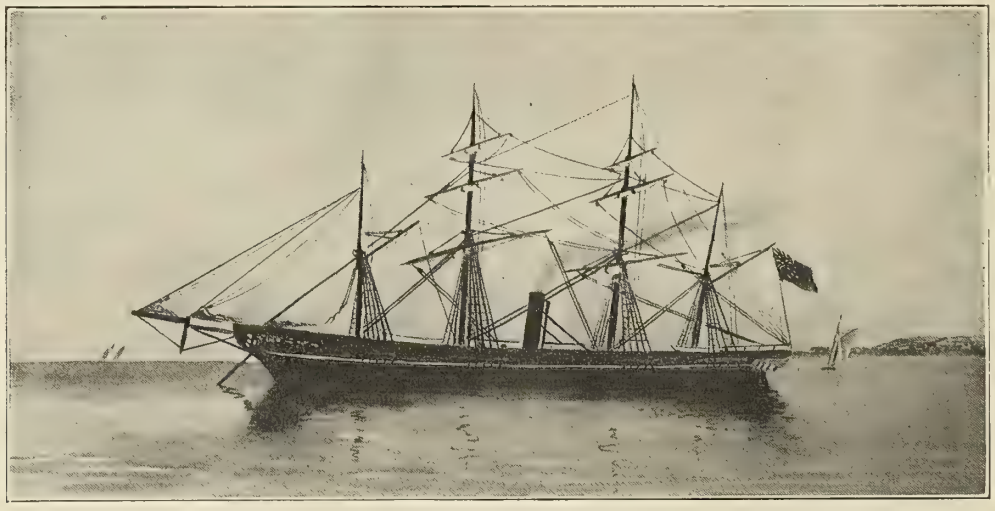
The "dutchman" idea comes when the liner is an afterthought, but when it is incorporated in the original design and its usefulness recognized, it assumes the dignity of a "liner." This elastic spacer occurs in no less an important location than between the very life of the ship itself, the engine, and the foundation upon which it works. Enough said. Why not adopt a good thing that has proven its worth through years of service and design, with a clearance that allows machined surfaces and a finished liner? E. B. W.

The Burning of the Sarah Sands

The burning of the *Sarah Sands* is an event which claims a record both in military history and in the annals of adventures on the deep. It would be difficult for imagination to depict anything more appalling than the scene presented by a ship on fire, freighted with hundreds of human beings, and drifting on a desolate sea, apparently to certain doom. Not a ship was sighted from the hour of the burning of the *Sarah Sands* until her arrival at Mauritius, and had she foundered (taking into consideration her position, 1,000 miles from land, and out of the track of ships) the affair never would have come to light, and, like the loss of the *President,* would have remained a mystery to the end of time. Several bottles containing statements to the effect that the vessel was on fire were thrown into the sea. None of them was since recovered.

The *Sarah Sands* was one of the earliest iron screw ocean steamers. She was built at Liverpool in 1846, and measured 1,400 tons gross, 182 feet long, 33 feet broad and 32 feet deep. The hull was divided into three watertight compartments by two iron bulkheads, and these proved to be her salvation, as will be seen further on. The machinery, made at the Clarence Foundry, Liverpool, consisted of two oscillating cylinders, each 50 inches in diameter, 3 feet stroke, 300 indicated horsepower, working upwards to the crankshaft, which was coupled direct onto the tunnel shaft, a most unusual practice in those early days.

This vessel sailed on her first voyage from Liverpool to New York on Jan. 20, 1847. She continued on this route (in conjunction with the Red Cross Line of American sailing packets) until December, 1849, then for two years traded between Panama and San Francisco. From that service she proceeded to Sydney, owing to the gold fever (as it was termed) prevailing in Australia. From there she returned to Liverpool, and later, in 1854, she went on the Canadian route, from



THE ILL-FATED SARAH SANDS, ONE OF THE EARLY IRON SCREW OCEAN STEAMERS

which she proceeded to the Crimea under charter to the British Government. During the Indian Mutiny, in 1857, the *Sarah Sands* was again chartered by the British Government, and sailed for India from Portsmouth on Aug. 15 of that year, having on board the headquarters of H. M. 54th Regiment—about 350 rank and file.

On the 11th of November, when 1,000 miles from any land, smoke was observed to issue from below. A cry of "Fire!"—that most horrible of all cries at sea—was raised. Measures were taken by the chief officer and the carpenter to discover the cause of the alarm, and, upon lifting the hatches, the smouldering materials stowed in the after part of the vessel burst forth into a blaze. The smoke so overpowered them that they were compelled to make a precipitate retreat to escape suffocation. All further efforts in this direction were then useless, and to make matters worse the crew (who had been mutinous and troublesome to the captain and officers ever since leaving England), with a few exceptions, seized two of the best boats and made off, leaving the others to their fate. The first thought of the commander was to secure a compass and a chart. Orders were given to take in all sail, and after

much difficulty, owing to the few hands left on board of the crew, the ship was hove to. The fire engine was put to work, but several streams of water produced no appreciable effect on the flames, which now mingled with the clouds of smoke in the saloon and made a most terrifying scene. There were five ladies on board; they were hastily put into a boat, provided with fresh water and such provisions as could be obtained, and lowered to the water. At about the same time Private William Wiles and a sailor, Quartermaster Richard Richmond, at the risk of their lives, struggled through the dense mass of smoke which filled the saloon and saved the colors of the regiment. These colors are now in the Norwich Cathedral. It is due to men of the 54th Regiment to say that they maintained perfect order during the whole period of the fire, which continued more than fourteen hours. In no instance was it necessary to find fault with any of them. The *Sarah Sands* carried a large amount of powder and ammunition stowed in two magazines; the starboard one was quickly emptied, but on account of the mass of hot suffiocating smoke the port one was found most difficult to reach.

Nevertheless, volunteers were found to attempt to clear this magazine. Major Hughes was the first to descend and pass up a cask of ammunition. His example was followed by several others, and most of the dangerous contents were brought on deck and thrown overboard. Two large barrels of powder remained, however, which no exertions could reach. Those in the boats were told to pull beyond the reach of danger, as in the event of an explosion the foundering of the ship would almost certainly take place. At about 9 o'clock P. M. the fire burnt through the upper deck and set fire to the jigger rigging. Soon the mast fell with a crash over the ship's side, and the rest of the rigging was cut away in order to release the burning mast, which was causing the stern of the vessel to veer round into the wind. The expected explosion now took place with fearful effect. The after cabins and saloon (or what was left of them) were blown yards into the air, and a part of the port quarter was blown out. The ammunition exploded with the brilliancy of multitudinous sky-rockets, and according to a letter in the *Times* of that day gave the vessel the appearance of a volcano in eruption.

The concussion caused by the explosion was so great that the stern of the steamer dipped, and for a moment was under water, and everyone believed she would settle down with all on board. In this apprehension rafts had been rapidly constructed of spars and any timber that came at hand; two of them were set afloat, and a third was left across the deck to be lowered in the last extremity.

The troops were still pursuing their arduous work and, to their credit be it recorded, not a man attempted to rush upon the rafts. The saving of the vessel and the hundreds of lives which she carried was unquestionably due to the discipline and courage of the officers and men. The deck was now cut through with axes, and men lowered to throw water on the burning mass and so keep the fire in check. It was next observed that the iron sides of the vessel were becoming red-hot, a discovery fearful enough to fill the bravest with dismay. Every particle of wood in the after part of the ship was destroyed, and as the flames shot up from below a blue vapor arose which hung over the red-hot iron underneath. Finally, at 9 A. M. on the 12th, after fourteen hours of desperate work, the fire was under control, and the feeling of suspense which every one on board must have suffered was in a measure relieved. The ship herself, however, was in a fearful condition; there was about 20 feet of water in the after compartment, in which were the water tanks, and each time the vessel rolled they were driven with such violence against the iron plates as almost to smash them to atoms; they were in a short time secured and further damage prevented. The heat had been so intense that the glass in the scuttles melted and hung down like icicles.

There is no doubt that if the *Sarah Sands* had been constructed of wood instead of iron she would have been lost; and the fact that she was fitted with three iron watertight bulkheads (the inside of one having always been kept wet by the soldiers) also contributed largely to her safety.

This fire and the ultimate saving of the ship did much to remove the prejudice then existing towards iron vessels. Shortly after the fire was put out the boats were picked up; fortunately no casualties had happened on board of them. The commander also allowed the sailors who were in the boats to return on board, although he observed they ought to have been cast adrift. As the vessel was very light and rolling and shipping seas where the port quarter had been blown out, two chains were passed round the stem to strengthen it, and canvas and anything that could be obtained was used to fill up the opening, and the leak was thus stopped. The ship, after the fire, was steered by ropes attached to the rudder head. Six men sat on planks on one side and six on the other, pulling and letting go as required. Under such conditions was the hull of the *Sarah Sands* navigated nearly 1,000 miles to the island of Mauritius—we believe a feat of seamanship unparalleled in the annals of any nation.

To add to the miseries of those on board the provisions and water were nearly all destroyed, and all hands were put on very short rations until Mauritius was reached, which happy event took place on Nov. 25. From there the 54th Regiment was transferred to another vessel and sent on to Calcutta. The *Sarah Sands* was temporarily patched up and returned to England under sail. She was then thoroughly repaired, her engines removed, and she sailed for Bombay as an ordinary sailing vessel, but ran ashore at the mouth of the Thana River, and was so badly damaged that she was abandoned.

FRANCIS B. C. BRADLEE.

Blemishes on Machine Work

No matter what our grade of intelligence may be, or what the nature of the work we perform for a living, we all like to see things that look pretty. It is for this reason, maybe, that we criticise blemishes and those who make them. Even in the cases where the blemishes do not in any way impair the strength, and where the cause of the same is beyond the control of anyone, we criticise just the same. All of the arts and trades have the same experiences, but the case of the rocker arm pin as described herein comes home to the marine engineer and the marine engine builder.

The incident occurred during the building of our "New Navy," which, of course, was quite a number of years ago, and a certain torpedo boat has served its country and gone to the scrap pile, yet the same story in substance is oft repeated to-day. When dealing with blemishes complications are likely to arise, because it requires rare judgment sometimes to distinguish between blemishes and defects. It would be expected that the builder, wherever possible, would say "repair," while it is equally certain, as experience has shown, that the Government inspector would say "scrap." Hence, it follows that the builder is frequently "up against it" and he is compelled to perform certain operations in the "dark," though these same operations may be of as great a value to the purchaser as to the builder.

One of the marine engine rocker arms mentioned above is shown in Fig. 1. These rockers were forgings with the pins *A* cut from the solid, as shown in Fig. 2. The holes *J, C, C* removed most of the stock, and the parts *D* and *E* were cut out, thus leaving a square pin, as shown in Fig. 3. Then the square pin was worked to an octagon and finally to the round to fit the brass templet in Fig. 4. To-day these pins would be turned by a special fixture on a lathe and the work done at a fraction of the former cost.

On one occasion when the pin had been cut down to within one-eighth inch of the finished diameter, a large slag hole *H* was opened up in the middle of the pin. It looked mighty ugly, but really did not impair the strength of the pin enough to matter, as the parts were extra strong. At the same time, however, unless the appearance was made good, the entire forging, with all the work done on it, would be a total loss. Therefore, before the pin was inspected, the blemish was

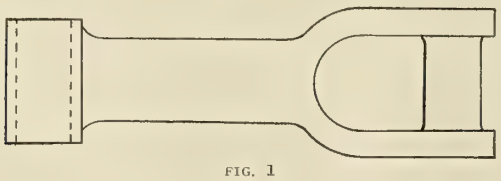


FIG. 1

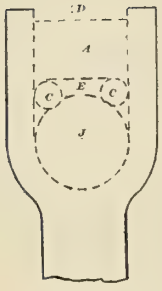


FIG. 2

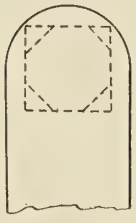


FIG. 3

FIG. 4

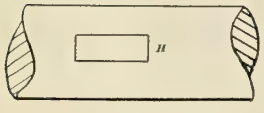


FIG. 5

FIG. 6

cut out, as shown in Fig. 5, forming a rectangle in the solid metal. Then a "dutchman," as in Fig. 6 enlarged, was set in and the metal peened to a tight fit. A second peening was given the block just before the last filing operation. The final finishing was done with emery and oil, the cloth being drawn over both the pin and the block. It was impossible to detect any joints between the two parts. No doubt many of the readers of INTERNATIONAL MARINE ENGINEERING have had some unusual experiences with both blemishes and defects in marine engines. Can you not express your views on the subject?

F. WEBSTER.

Scranton, Pa.

Iron versus Steel

With the increase in physical properties of the materials of construction, the weights per horsepower of marine machinery have been greatly reduced, but the life of boilers made of high grade steel does not compare favorably with that of the old-time boilers built of iron. It is unnecessary to dwell on relative merits, or even to discuss the reasons for the change, but a glimpse at the cost of upkeep of the boilers built of charcoal iron and those of steel for the same size engines and the same working pressure would be of interest, and I think the following case bears out any argument which can be made:

In the year 1885 a lighter was built for the Long Island Railroad Company by W. & A. Fletcher Company, Hoboken, N. J. This lighter is fitted with a fore-and-aft compound engine, having cylinders of the following dimensions: High-pressure, 16 inches; low-pressure, 28 inches; stroke, common to both, 24 inches. The working steam pressure is 100 pounds gage. The boiler is of the well known and extensively used leg type, having the following dimensions: Width of front, 8 feet; length, 14 feet; shell diameter, 8 feet. There are two furnaces having a length of 6 feet 6 inches. The center leg of the furnaces is 5⅝ inches outside; the wing legs, 4⅝ inches outside. There is a combustion chamber 26 inches deep. The flues are of the following dimensions: Two flues, 13 inches diameter; two flues, 10½ inches diameter; two flues, 16 inches diameter, having a common length of 4 feet 6¾ inches. There is a wet-front connection 35¾ inches deep. The tubes are 3¼ inches O. D., having a length of 8 feet 6 inches. There is fitted a vertical steam drum in the center having a diameter of 48 inches and a height of 48 inches. The stack connection is 36 inches diameter and the height of front 8 feet 9 inches.

Here is a boiler that has been in constant service for twenty-seven years, and has the following record: The tubes and flues are as perfect as the day they were put in. The steam pressure has not been cut one pound. Mr. H. L. Des Anges, superintendent of the marine department of the Long Island Railroad, is, like the writer, a firm believer in the use of kerosene (paraffin) for boilers. The condition of this boiler shows the wisdom of the use of the above, for there is no scale and the water used is from the East River, and far from excellent. Can such a record be produced with a boiler built of steel and used in the same service?

The engine, I should have mentioned, is jet condensing. This boat is a lighter, but when a tug is undergoing repairs it is used for a tug, towing car floats. Again, it is used for the instruction of junior engineers, and from this it is evident that the machinery not only can, but repeatedly does, stand severe usage. There is no reason to doubt that the engines and boiler would wear out another hull, and should they be removed and installed in a hull used for towing, would show a fine record for years to come.

I am indebted to Mr. Ebsen, chief engineer of the W. & A. Fletcher Company, for the particulars of this boiler and engine.

New York. CHARLES S. LINCH.

Strange Happenings

The following incident was related in a recent issue of the *Marine Journal* by its well-known editor, Captain George L. Norton:

"During the civil war the steamship *Saxon*, a transport in the service of the U. S. Quartermaster's Department, of which the writer was first officer, was sent north from Hilton Head, S. C., to have her machinery overhauled.

"Just before sailing the chief engineer and his two assistants, who, by the by, were his sons, took off the cylinder head, cleaned out the cylinder, the chief leaving the boys to put the cover back again, he in the meantime attending to some other duty. We left the dock the next day, and when passing through the Narrows a tremendous thump in some part of the machinery that was felt throughout the ship caused the chief engineer to shut off steam and the vessel to come to anchor. The shock came from the interior of the cylinder, so as soon as it cooled sufficiently to take off its cover, to the surprise and mortification of the chief and his assistants there was an S wrench found lying on top of the piston with one end of it flattened out as thin as a knife blade. This wrench was perhaps a foot and a half long with a slot in each end fitted to straddle the nut on the end of the piston rod, which held the piston in place. There was just space enough in the cylinder when the piston was on the up-stroke for the nut to clear the cylinder head. The wrench evidently got on top of the nut in some way and the blow flattened it out, but fortunately did no damage.—G. L. N."

Marine Articles in the Engineering Press

The Generation and Electrical Transmission of Power for Marine Transportation.—By William P. Durtnall. This paper was presented before the Society of Engineers and contains practically a history of the development of electrical transmission for propulsive purposes. After studying the conditions to which motive power for driving a propeller should conform, the suitability of electrical transmission for this purpose is thoroughly explained. Nearly all of the important installations of electrical transmission on board ship are described in detail. 5,750 words.—*The Steamship,* December.

Twin Screw Steamer Indarra.—The *Indarra,* a ship of 9,200 tons and 10,000 horsepower, has been built and engined by Messrs. Denny Brothers, Dumbarton, for the Australasian United Steam Navigation Company. The ship is a splendidly equipped passenger and cargo vessel. The machinery consists of two sets of quadruple expansion engines, with cylinders 26½, 38, 54 and 76 inches in diameter, with a stroke of 4 feet. Steam at a pressure of 210 pounds per square inch is supplied by seven single-ended boilers, working under Howden's system of forced draft. On her maiden voyage the vessel steamed with only five boilers in action at a speed of 16.68 knots. 9 illustrations. 1,450 words.—*The Marine Engineer and Naval Architect,* December.

Self-Discharging Collier.—By Frederick C. Coleman. William Doxford & Sons, Ltd., have recently built at the Pallion Shipyard, Sunderland, the steamship *Herman Sauber,* to the order of Sauber Brothers, of Hamburg. The vessel has a length of 315 feet between perpendiculars and a carrying capacity of 3,750 tons on a draft of 18 feet 9¼ inches. The service speed is 10 knots. The machinery, comprising triple expansion engines and forced draft boilers, is placed aft. Cargo is discharged by two conveyors, one on each side of the boat, running fore and aft below the holds, the cargo being fed to the conveyors by gravity. The conveyors are constructed on the Doxford patent system of continuous steel rope drive. They rise at a proper inclination through the machinery space and deliver the cargo in the stern of the vessel, where it is received on a second pair of conveyors and conveyed forward, and at the same time elevated to a suitable point of discharge. The feeding arrangement for the cargo to the conveyors is by means of drop feed doors spaced at regular intervals along the hold. When the vessel discharges on both sides from the two conveyors the cargo is delivered at the rate of from 400 to 800 tons per hour. The cost of discharging, including coal, oil and labor, is less than a farthing per ton. When a proper supply of receiving barges is arranged, the *Herman Sauber* can complete discharging in six hours for any coal except Welsh, which may take nine to ten hours. 6 illustrations. 1,800 words—*The Marine Review,* December.

Results of First Voyage of the Oil-Engined Ship Christian X.—The maiden voyage of the *Christian X,* which is a sister ship of the*Selandia,* previously described, of 7,400 tons displacement and 2,500 horsepower with twin screws, built by Messrs. Burmeister & Wain, Copenhagen, commenced July 28 and lasted 17½ days. The ship covered a distance of 4,627 nautical miles, the mean fuel consumption per indicated horsepower per hour being .370 pound, disregarding the small difference between the British and the Continental horsepower. Both the main and auxiliary engines worked well through the voyage. Rather thick and dry deposits were noticed on the portions of the cylinders and pistons not subject to rubbing effect. These were ascribed to the high percentage of sulphur and of mineral constituents in the fuel. For the same reason probably all the exhaust valves of the main engines had to be replaced and nearly all the valves and valve seats had to be turned true again. As regards the attendance, the air injectors had to be cleared of water almost every two hours, owing to the high humidity of the oceanic atmosphere. The discharge valves had to be kept in a throttled condition, and consequently did not keep tight. The valves thus necessitated a good deal of repair. On the other hand, the crossheads, the cranks, the guides and the bedplates of the two engines withstood the strains of the voyage quite well. During trial runs which lasted twenty-four hours, the fuel consumption per indicated horsepower per hour of the main engines worked out as .338 pound. The fuel consumption of the auxiliary compressors per indicated horsepower per hour was .365 pound. The total fuel consumption of the main engines and compressors during the twenty-four-hour trial was .367 pound per indicated horsepower per hour. The normal speed of 11.5 knots was reached during the trial. The average speed throughout the maiden voyage was 11 knots 1,200 words.—*Engineering,* Jan. 3.

The Story of the P. & O. Line.—An interesting account is given of the origin and development of the well-known P. & O. Line, including a description of the different types of vessels which have been entered in this service. All the earlier vessels were wooden paddle steamers, but as the science of shipbuilding advanced these were gradually replaced until the modern type of twin-screw steamer now employed in this line has been developed. The main fleet of the company now comprises 71 vessels of 543,961 tons built and building. In addition to these vessels there is a large number of tenders, barges, tugs and auxiliary vessels. 10 illustrations. 3,200 words.—*The Marine Engineer and Naval Architect,* January.

Boat Stowage and Davits.—The scheme of stowing and launching lifeboats on board ship, proposed by Mr. Charles Doxford, of Messrs. William Doxford & Sons, Sunderland, is described in detail. The davits are of the pivoted type and the boats are supported in chocks inboard. When the chocks are released the davits swing out and the boat is lowered by gravity. Friction brakes, acting on the boat falls, give the operator control of the launching. This arrangement can be made to accommodate two tiers of boats, one above the other. The upper tier is attached to longer davits, which swing the boat outboard of the lower tier boats when they are lowered. The lower tier of boats would be launched first and the upper tier would follow immediately. A diagram is given showing how this arrangement could be supplied to such a ship as the *Mauretania,* and boats having a capacity for all on board could be provided. 5 illustrations. 680 words.—*The Shipbuilder,* January.

Some Modern Systems of Ship Construction.—An outline is given of some of the main departures in recent years from the usual practice in ship construction. The first considered is the arch principle (Ballard patent) in which the upper part of the transverse section is treated as an arch. Above the molded depth line an arch is built which supports the deck and all probable top weights without any pillaring being necessary, but, at the same time, maintaining the buoyancy and draft of the vessel economically and affording a free hold. The second system discussed is the McGlasham, which embodies a second skin to provide safety against foundering in the event of collision. For a considerable portion of the length of the vessel the double bottom extends up the side to the weather deck. The capacity for water ballast of the side tanks thus formed is about three-quarters that of the bottom tank, extending from bilge to bilge. The next system described is the Harroway-

Dixon system, in which the distinctive feature is a cantilever frame combined with wing tanks. At about midway between the inner bottom and the deck the frame is bent through an angle of 45 degrees, thus forming a cantilever which supports the deck without the need of pillars, thus leaving perfectly clear holds. Other systems described are the well-known Isherwood system of longitudinal framing and the Monitor system, which is designed to increase both longitudinal and transverse strength, decrease rolling and also decrease the power required for propulsion. 13 illustrations. 4,300 words.—*The Marine Engineer and Naval Architect,* January.

Large Single-Deck Cargo Steamers.—By H. Bocler. Strictly speaking, a single-deck vessel would be one having a single continuous upper deck with no tier of hold beams and no long side-to-side erections on the upper deck. In practice the term "single-deck vessel" is extended to include ships with a tier of wide spaced hold beams, and with long erections, provided these do not extend over the full length of the ship. Thus the single-deck type with erections virtually merges into the shelter deck type when very long erections are adopted. The way in which the stringers and tiers of beams have been gradually eliminated since this type of vessel was first built is described in detail. The first real single-deck ship of considerable depth was the *Lincluden,* 312 feet by 42 feet 4 inches by 26 feet 3 inches, built by Messrs. Furness, Withy & Company at West Hartlepool in 1896. At the time of building she was considered to be a radical, if not dangerous, departure, but fears in this respect proved to be unfounded, and after that date many vessels were built, some having depths up to 29 feet 6 inches, in which reliance was placed solely upon deep framing unsupported by beams of any kind below the upper deck. As an example of the modern type of single deck cargo steamer a complete description is given of the *Hannington Court,* a typical modern cargo carrier, with a deadweight capacity of 8,500 tons on 23 feet 10½ inches draft. Her dimensions are: Length between perpendiculars, 400 feet; breadth, extreme, 53 feet 6 inches; depth, molded to the upper deck, 29 feet ¾ inch. This vessel has exceptionally clear holds free from pillars, except for the few necessary to support the hatch corners. In order to limit the size of the frames a tier of wide-spaced hold beams has been introduced. Apart from the deep hold stringer no side stringers are fitted except at the fore end. In conclusion, reference is made to the Isherwood system of construction as applied to such ships, and also to special forms of ships, such as the cantilever, the turret and trunk types. 9 illustrations. 2,200 words.—*The Shipbuilder,* January.

On Shearing Stress in a Ship's Structure.—By K. Suyehiro. This is a paper read at the recent meeting of the Japanese Institute of Naval Architects. Accepting the work of different investigators concerning the maximum shearing stress in a ship's structure as valid, the author finds that all conclusions as to the distribution of shearing stresses differ in many respects, and he has tried to throw some light on this subject. The analogous case of the shearing stress in a thin hollow cylindrical beam is taken as the basis of the investigation. Under the assumption that the inference deduced in the above case holds in a ship's section, the author has calculated the shearing stresses in an existing steamer. The paper describes how the calculations were made for the deck plating, bilge plating and double bottom. In his conclusions he calls attention to the well-known phenomenon that in not very rare cases the seams of bilge plating of iron ships, as well as of wooden ships, are subjected to the severest stress. This has been so far attributed to the shearing stress which is caused by heavy rolling when the neutral axis might happen to pass through the bilge plating. In the author's experience the weakness in bilge plating has sometimes been observed in boats of limited service, which have never been subjected to heavy rolling. From the stress diagram calculated it is seen that the shearing stress in the bilge plating does not fall off sensibly. Moreover, this plating, especially at the seams, is generally subjected to corrosion on the inside and to wear on the outside. The author suggests that these two causes may explain the weakness in bilge plating. It is also observed that the heavier the double bottom is constructed the more severely will the bilge plating be strained. Therefore, it seems that some distinction for the strength of bilge plating must be made in one way or another between ships having a double bottom and those with an ordinary floor. Also in the inner bottom and in the main deck plating the shearing stress is comparatively low. Therefore, double riveted seams may not be necessary for them. The British Corporation Rules have already given practical attention to this construction. The author points out that these inferences have been arrived at from a purely theoretical point of view. In actual ships a part of the shearing force will be taken by transverse members. The true quantitative values of shearing stresses can be found only by actual observations in a ship, and the author emphasizes the necessity of actual measurements of strains in ships for the further development of naval architecture. An approximate formula is given for determining the maximum shearing stress. 3 diagrams. 2,100 words.—*Engineering,* Dec. 27.

Shipbuilding Premiums in Russia.—A list is given of the shipbuilding premiums calculated per registered ton of the vessel's full tonnage prescribed in a law passed in Russia which came into effect Jan. 1, introducing premiums for Russian-built vessels subject to certain conditions. A premium is paid to shipbuilders within the Russian Empire for each vessel built by them for traffic in foreign waters and on the Danube with its tributaries, such vessels being of metal for merchant service, commenced after the publication of the law, and when completed registered as belonging to a Russian port. Further premiums are offered for indicated horsepower at the installation of new main or auxiliary engines, and for the repair and replacement of old boilers with fittings, etc. The premiums thus specified, after the lapse of ten years reckoned from the day of publication of the law, will be subject to an annual reduction of 6 percent. The law is to remain in force for fifteen years. 400 words.—*Engineering,* Dec. 27.

Progress in Naval Construction.—This article is an editorial review of naval construction in Great Britain during the year 1912. Attention is called to the increased time required and cost of recent battleships as compared with the construction of the *Dreadnought* in 1906, which went into commission fourteen months after the order was issued. At the present time, with the increase in size of both hull and machinery units, as well as on account of the boom in merchant shipping, two and one-half years should be allowed for the construction of the largest warships. The increase in cost is attributed largely, of course, to the increase in size and account is also taken of the increased cost of labor and material. One notable feature pointed out is the efficiency of the dockyard work, where there has been less delay than in some of the private yards. The total number of vessels launched in 1912 for the British Navy is 28; collective displacement tonnage, 167,495; the total horsepower of propelling machinery, 550,000. In 1911, 41 British warships were launched, aggregating 220,980 tons, with a total horsepower of 722,300. The total value of ships completed in 1912 is £4,000,000 less than in 1911. The main particulars of the various ships launched during 1912 are given in detail. A noteworthy feature mentioned is the uniformity and favorable character of the coal economy in the larger ships. At full power the consumption of coal was 1.7 pounds per shaft horsepower per hour. In almost every class of vessels the contract speed was exceeded on trial, frequently with an exceptional increase, although the rates of speed published in the daily press were in most cases grossly exaggerated. 5,500 words.—*Engineering,* Dec. 27.

Ten Thousand Horsepower Föttinger Hydraulic Transmission Gear.—Mention is made of the first Föttinger transmitter, described in a previous issue, which was fitted in 1909 on a small steamer which has since been in regular service in the port of Hamburg between Hamburg and Stettin, a gear which has proved reliable and accurate in action. The second transmission gear was fitted in a British boat in connection with gas engines and showed a maximum efficiency of over 88 percent. The 10,000 horsepower installation described was designed for use in a new liner for a German shipping company. It was designed for transmitting normally 10,000 horsepower at a speed of 850 revolutions per minute for the primary shaft and of 170 revolutions for the secondary shaft. This plant, set up in the builders' shops for tests, has undergone a continuous trial of two weeks' duration on a high load. The primary part of the transmitter was coupled direct to a Curtis A. E. G. Vulcan type turbine, and the secondary part was coupled to a shaft, the power being taken up by a large hydro-dynamic Föttinger brake. The steam turbine was run at different speed; reversing took place at different intervals for momentary action and for running reversed during varying lengths of time. The efficiency obtained was close up to 90 percent. Other installations of the same type of gear already under construction are also mentioned. 3 photographs. 900 words.—*Engineering,* Dec. 13.

The Shallow Draft Steamer Comte de Flandre.—Yarrow & Company, Ltd., of Scotstoun, Glasgow, has recently constructed for Lever Bros., Ltd., of Port Sunlight, a shallow draft river steamer intended to run on the Congo to bring oil from the upper reaches down the river. The hull is 190 feet long, 30 feet beam, 8 feet molded depth, built of galvanized steel. The boat is propelled by one set of triple expansion engines driving a single screw working in a tunnel fitted with the firm's latest type of patented hinged flap, which is arranged to work automatically, being balanced by balanced weights. The hull is divided into ten compartments, including the engine and boiler rooms, which are placed amidships. Forward of these are three cargo holds having a total capacity of 10,080 cubic feet, while aft there are holds having a capacity of 11,950 cubic feet. The deadweight cargo capacity is 250 tons, on a draft of only 4 feet 6 inches, and the estimated speed is 10 knots. Accommodation is provided for ten first-class passengers in separate single-berth cabins on the spar deck aft. Steam is supplied by two locomotive type boilers constructed by the North British Locomotive Company, Glasgow. The designs and construction of this boat were supervised by Messrs. Esplen & Sons, Liverpool. 5 illustrations. 725 words.—*The Engineer,* Dec. 27.

Proposed Rhine-North Sea Ship Canal.—The current year has witnessed the introduction of a scheme for the establishment of a great ship canal between the Rhine and the North Sea at Emden, so as to render the west of Germany independent of the Waal or Dutch section of the Rhine. At a conference held in the Banquet Hall of the Prussian Diet in Berlin on Nov. 15, two proposals were discussed. The first, or Herzberg-Taaks project, contemplates the construction of a ship canal from Wesel along the Dutch frontier to Emden, a large portion of the route consisting of uncultivated land and moorland. The second, or Rosemeyer project, provides for the canal to commence in the vicinity of Cologne at Wiesdorf, where the level of the Rhine is much higher than at Wesel, thus affording a natural fall from the Rhine to the North Sea at Emden. The scheme proposes a canal having a navigable channel of a depth of from 23 feet to 30 feet and a width capable of permitting one vessel to pass another in any place on a two-ship canal. It is calculated that the length of the waterway would be 168 miles, and that a considerable economy in time would be realized as compared with a route via the Waal to Rotterdam, while the time economy would be enormously increased as contrasted with shipments via Rotterdam and the Borkum Lightship to ports further north. Apparently these schemes meet with strong opposition from business interests, which it would be expected would benefit largely by such a canal. 1,300 words.—*The Engineer,* Dec. 13.

U. S. S. Fanning and *Jarvis.*—By Henderson B. Gregory. Reference is made to the descriptions of these two vessels which were published in previous issues of this journal. In this article is given trial data obtained from the official progressive, full speed and endurance trials. In accordance with the present custom of the Navy Department figures are given only of the speed and horsepower. 2 illustrations. 2,500 words.—*Journal of the American Society of Naval Engineers,* November.

Comparative Tests of Three Types of Turbine-Driven Forced Draft Fans.—By W. J. A. London. On account of the increasing use of turbine-driven forced draft fans in the navy, a series of tests was carried out at the works of the Terry Steam Turbine Company, Hartford, Conn., to determine the relative efficiency of three distinctive types of fans when combined with a standard Terry vertical turbine. The turbine was the maker's standard type "BV," being a duplicate of over fifty machines now in use in the navy. The normal rated capacity was 60 horsepower, with a throttle pressure of 250 pounds and a terminal pressure of 10 pounds gage at a speed of 1,400 revolutions per minute. The first fan had a rated capacity of 23,000 cubic feet of free air against 5-inch static pressure by water-gage at a speed of 1,400 revolutions per minute. The second fan was rated at the same capacity, but at a speed of 2,200 revolutions per minute, and the third fan was rated at the same capacity as the first one. A detailed description is given of the method of testing the machines, which is followed by tabulated results of the tests, including curves derived from this data. 10 illustrations. 1,800 words.—*Journal of the American Society of Naval Engineers,* November.

The Kingsbury Thrust Bearing.—By Lieut. W. W. Smith, U. S. N. In the thrust bearing recently invented by Mr. Albert Kingsbury, of Pittsburg, the load is uniformly distributed over the entire bearing surface, and the slippers are free to adjust themselves at slight angles to the collar, so as to glide or skim over the film of oil which adheres to and moves with the collar. In high-speed bearings a pressure of 500 pounds per square inch is being carried and in low-speed bearings 900 pounds. The safe maximum pressure which can be carried on these bearings is much greater than the above figures indicate, as a recent test on a turbine thrust bearing showed that a pressure of about 7,000 pounds per square inch could be carried without breaking down the film of oil. A description is given of the Kingsbury thrust bearings which were fitted to the turbines of the United States collier *Neptune,* which so far have given excellent results as regards both operation and repairs. The unit pressure on the *Neptune's* thrust bearings is 500 pounds, and the surface speed 4,300 feet per minute. This gives a large factor of safety or overload capacity which is a decided advantage. In conclusion, the faults which have been found to exist with the ordinary collar thrust bearings are pointed out, showing the desirability of the Kingsbury thrust bearing in comparison. 4 illustrations. 4,200 words.—*Journal of the American Society of Naval Engineers,* November.

OIL ENGINES FOR THE ADMIRALTY.—According to *Engineering* the British Admiralty have ordered oil engines for the propulsion of two more ships for carrying oil fuel for the supply of warships at sea. These ships are to be built at the dock yards. One set of machinery of the Fiat type will be constructed by Scotts Shipbuilding & Engineering Company, Ltd., of Greenock, and the other, of the Nürmburg type, by the Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow.

New Books for the Marine Engineer's Library

Theoretical Naval Architecture

REVIEWED BY PROFESSOR C. H. PEABODY*

Text-Book of Theoretical Naval Architecture. Sixth edition. By Edward L. Attwood, Mem. Inst. N. A., Mem. Royal Corps Naval Constructors. Size, 5 by 7¼ inches. Pages, 511. Illustrations, 145. New York and London, 1912: Longmans, Green & Company. Price, $2.50 net.

This book, which may be considered as a standard for its class, was first published in 1899 and has now reached the sixth edition, which has been enlarged from the original 292 pages to 511 pages. The book was written for a particular purpose, and throughout the several editions the author has adhered definitely to that purpose, which has evidently been attained. That purpose, as stated in the original introduction, was to provide a text-book for students and draftsmen and to give preparation for examinations of the Science and Art Department (now the Board of Education). The increase in bulk of the last edition is in large part due to the secondary object, as evidenced by the fact that the space given to sample examination papers has been increased from 36 pages to 94 pages. At the same time the modest appendix of 13 pages, which dealt with such subjects as Simpson's rules and theory of launching, has been increased to 94 pages and includes such subjects as rolling among waves and the more intricate question of propulsion. The treatment of the book, especially as it refers to examinations, has impressed upon it a clearness and conciseness of expression that is notable, and, further, there are offered a large number of problems like those included in the examinations which are of the greatest advantage, especially to young men who depend largely on themselves. The appendix is not so adequately handled, for it treats in small space a number of problems which have unavoidably considerable complexity and do not offer satisfactory partial treatments; one may almost say that they should be treated adequately or else omitted. If the appendix is considered as a brief résumé of the subjects presented, and if the student may be expected to master them by reading the references which are recommended, then our criticism loses its edge, and yet the reading of original memoirs is a serious matter for students whose attainments are indicated by this book.

The author remarks: "For the bulk of those who study the subject of naval architecture, the only instruction possible is obtained in evening classes, and this must be supplemented by private study. The institutions in which systematic instruction in day courses is given are few in number * * * and students who can obtain the advantages of this training are comparatively few in number." This refers to the very extensive and efficient system of evening instruction in vogue in Great Britain, and which is fostered by all the technological colleges, which have evening classes frequently many times larger than their whole day registration. A liberal estimate is that an evening student, who is commonly an apprentice in some work, may accomplish a third as much in a year as a day student, and while evening classes are offered for work of any grade in demand, the result is that evening students cannot be expected to obtain much more than that proportion of the theoretical training given to the regular college students. This is no place for the discussion of the merits of a system of education which is wide in its scope and sound so far as it goes, but it is interesting now because it helps us locate the class for which this book is written.

If another digression may be permitted, attention may be called to the large part in education played by formal examinations which are commonly set by persons not connected with the school, partly to secure breadth of view and practical application, and partly to insure a fair field and no favor in contests in which there are rewards like scholarships in the regular college courses. The sets of examinations in the appendix are a logical outcome of this system, and though less directly, the large number of problems scattered through the book may be credited largely to the same influence. A notable and most valuable feature of the book is the direct practical application of methods taught, and for such purpose, especially for students who must rely largely on themselves, there is no better method than the solutions of problems, so long as such problems do not degenerate into numerical computations so long or involved that the student loses his view of the principles. The problems in this book have been in large part selected from examination papers drawn up as explained above, and others were made up with the same object of practical applications, and where the subject matter of the text can be illustrated by brief problems one cannot ask for better. Nothing can be better than the following problem, which may have been taken directly from practice:

"A vessel of 1,792 tons displacement is inclined by shifting 5 tons already on board transversely across the deck through 20 feet. The end of a plumb line 15 feet long moves through 5¼ inches. Determine the metacentric height at the time of the experiment."

But the same commendation cannot be given the problem below:

"Ascertain the displacement and position of the center of buoyancy of a floating body of the length 140 feet, depth 10 feet, the forward section being a triangle 10 feet wide at the deck and its apex at the keel, and the after section a trapezoid 20 feet wide at the deck and 10 feet wide at the keel, the sides of the vessel being plane surfaces; draft of water may be taken as 7 feet."

To our mind this is an ingenious attempt to replace for the real problem of finding the displacement of a ship from its lines, an artificial problem involving the essential principles in a form short enough to be answerable during an examination. But it is in our opinion an instance of the impracticability of an attempt to be practical under the circumstances. The fact is that the proper training is to be attained only by working in customary methods on lines of a ship; such training can best be attained under an instructor, who is the only person who can determine whether the student is competent. We would not make so much of an item of this did it not to our mind stand for a principle. The matters that must be treated under the head of theoretical naval architecture are many and various. Some are simple enough to be evident to anyone with a knowledge of geometry, whether he has consciously studied that subject or not, and others for adequate treatment require the higher mathematics; and, further, some which are simple in general principles are long and involved in application. The greater part of theoretical naval architecture falls under one or the other classification, either the principles are simple and need little illustration by problems which in practical computation are long and difficult, or else the theoretical treatment is involved if not difficult, while the numerical computations are brief and seldom required in practice. Testing the competence of students by numerical problems leads to over emphasis of secondary matters or else to artificial problems of problematical value.

If our criticism is just, it is of the system and not of the

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author, and the practical application is that the student in this country who has not a governmental examination before him should solve problems with discretion for which he must rely either on his instructor or on some senior in the profession.

Of the eight chapters, five are given to the geometry of shipbuilding, such as displacement, center of buoyancy, metacenters transverse and longitudinal, and stability both statical and dynamic. All this is susceptible of treatment by comparatively simple methods, and much of it can be illustrated by problems. No better presentation can be asked than that of the book, especially if we keep in mind the class of students for whom it is written. Our only regret is that mechanical integrators cannot have larger notice, but that is one of the privations of the class of students so large in number that inexpensive methods must be used. The general application of such instruments in practice makes it most desirable that students should be familiar with them, and the fundamental principles are most clearly taught when students may learn them unclouded by long numerical computation.

The calculation of the weight of the hull is both very important and very difficult in practice, while the statement in any text-book is necessarily brief and inadequate. The calculations of weights and strength of details and fittings where possible demand a good knowledge of applied mechanics and strength of materials, and can have place in a text-book of naval architecture only in so far as such details are peculiar to a ship. Such, for example, is the discussion of riveted joints as used on ships. An item worthy of notice in this edition of the text-book is John's investigation of the strength of shaft brackets.

There is only one way of knowing whether a ship is strong enough for her service, and that is to send her to sea and watch her behavior. Fortunately, a ship is likely to show evidence of weakness or lack of stiffness long before there is real danger of failure, and modern ships seldom if ever are lost at sea on account of structural weakness. Nevertheless, the only way of inferring the sufficiency of a new design is by some logical comparison with ships already built and in service. For this purpose, it is sufficient to use the method prepared by Rankin of computing the stress in the hull as a beam loaded with the known weights and buoyed up on the crest of a wave having its own length, or supported across two crests at the ends of the ship. The customary assumption of a trochoidal wave should always be made, firstly because it *is* customary, and secondly because it is at least as good as any other. It must be distinctly understood that the apparent stress determined by this method is a conventional figure which has little direct relation to the real stress in a ship at sea. The stress so determined for a large steel ship is liable to look excessive, though the ship is undoubtedly able; for a small ship the stress looks small, but no one proposes to reduce the scantlings for that reason. When the computed stress varies much from customary figures, then the designer considers whether the design should be modified. Having this in view, the "Smith" correction for the dynamic pressure of the wave is a curiosity that should be included in the course for students in colleges so that they may not overlook it, especially as the correction is of the order of five percent, which no man can interpret into an opinion regarding the safety of the hull of a ship.

The eighth and last chapter of the book gives a brief résumé of the problem of powering a ship, perhaps because the propeller and the engine to drive it are claimed by the marine engineer. In a book of this size sunch a résumé is perhaps all that can be given, but since the naval architect is expected to give the required power as the basis of the engine design this brevity must be regretted.

To sum up this text-book is recommended to all students of naval architecture. It is well adapted to the needs of those who have not the advantages of a full college course and students in such a college will find its treatment clear and direct and will welcome its practical atmosphere.

Two Books on Boiler Construction

REVIEWED BY H. H. BROWN*

THE THEORETICAL AND PRACTICAL BOILER MAKER AND ENGINEERS' REFERENCE BOOK. By Samuel Nicholls. Size, 4¾ by 7¼ inches. Pages, 273. Numerous illustrations. New York, 1912: J. S. Ogilvie Publishing Company. Price, $2.50.

It would seem a somewhat difficult task to compile a book which would be equally useful for the practical workman in the boiler shop and the engineer who has to design the work. This book, however, covers such a wide range of topics essential to a thorough understanding of the work of boiler making, that it will be found a useful aid in the drawing office of the engineer as well as in the hands of a layer-out or foreman boiler maker who directs the actual construction work. The aim of the author, as expressed in the preface, has been to express everything as clearly as possible, so that no formulæ will be encountered which cannot be easily mastered by anyone possessing a fair knowledge of arithmetic. The book begins with a table, giving the diameters, circumferences and areas of circles, information which is indispensable in boiler work. Tables are also given of the dimensions for internal and external angle iron and tee bar hoops, with rules for ascertaining the required length of a straight bar for the formation of any hoop which is likely to be used in boiler work. These are followed by tables of weights of different materials and shapes commonly used in boiler making. The subject of the strength of boilers is taken up in detail, and the methods of calculating various parts are explained by examples. A very complete chapter is given on riveting, which is accompanied by tables giving the pitch and diameter of rivets for different thicknesses of plate. An important chapter is that discussing the repairs of steam boilers. Welding, construction, setting, boiler power, incrustation and calculation of the ordinary lever safety valve are also discussed in detail. The last chapter in the book is upon templet work, and this the author considers as of more importance than any other given in the volume. We quite agree with the author as to the importance of templet work in boiler making; but we think that it deserves a more extended treatment than is accorded it in this chapter. The simple problems explained present no insurmountable obstacles to the beginner, but the actual application to sheet metal work requires further study than is outlined in this volume.

PERKINS' TABLES. By Lyman B. Perkins. Size, 5 by 7½ inches. Pages, 361. Hartford, Conn., 1912: Lyman B. Perkins. Price, $5.00.

This book contains a large number of convenient tables for use in the calculations for safe working pressures on boilers, compiled by a man who is a past assistant engineer of the United States navy, and who has been employed in various capacities for 25 years by one of the large boiler inspection and insurance companies, and at the present time is holding a certificate of competency as an inspector of steam boilers in the Commonwealth of Massachusetts. Evidently the author has found, and apparently appreciates the fact, that any one else who has regularly or occasionally the duty of calculating the safe working pressures to be allowed on boilers also finds that this work is not only tedious but objectionable as a source of possible errors and waste of time in checking up and correcting the original work. Realizing this, he has set to work and compiled the actual values, calculated absolutely in

* Editor of *The Boiler Maker*, New York.

accordance with simple rules governing particular cases, of the safe working pressure to be allowed on boilers. The results obtained and tabulated in the book were derived by the use of whole numbers and decimals, if any existed, to such an extent that the tabulated results are practically absolutely free from error. Where particular laws or rules governed calculations such laws and rules are absolutely adhered to. Those familiar with the usual procedure for obtaining the safe working pressure of the boiler know that it requires at least four operations of multiplication and division after certain values entering into the computation have been calculated by numerous other computations. The tables published in this book cover these operations to the extent that only a single multiplication and a simple division are required to obtain the result.

The first tables in the book give the bursting pressures of thin hollow cylinders without a joint. Next comes the subject of head bracing, with complete tables for the ordinary sizes of heads commonly used. Following this are tables of segmental areas. Then, practically the rest of the book, or about three hundred pages, is given up to tables showing the strength of riveted joints. These tables include lap and butt joints calculated for sixteenth-inch variations in pitches for lap joints, and for thirty-seconds in variations in close pitches and butt joints; for the different tensile strengths found stamped on the plates, both iron and steel; for the various shearing values of iron and steel rivets approved by use or special law; for thicknesses of material varying by thirty-seconds inch from one-quarter inch up to fifteen-sixteenth inch. A complete table of pitch joint efficiencies is tabulated, which is calculated in strict compliance with the law as given in the rules of Board of Boiler Rules of the Commonwealth of Massachusetts recognizing the specific value given to the shearing of steel rivets, the crushing value of steel plates, and also the least thickness of butt straps estimated with each thickness of plate. In addition to these tables on joint efficiencies two separate tables are given which may properly be termed keys to efficiency calculations, as they are provided to reduce to a minimum the labor of calculating the efficiency of a pitch joint. The methods of calculating these efficiencies are fully explained on pages immediately preceding the tables. This book is most assuredly a valuable aid to boiler makers.

COAL. By E. E. Somermeier. Size, 6 by 9 inches. Pages, 175. Illustrations, 8. New York, 1912: McGraw-Hill Book Company. Price, $2.00 net.

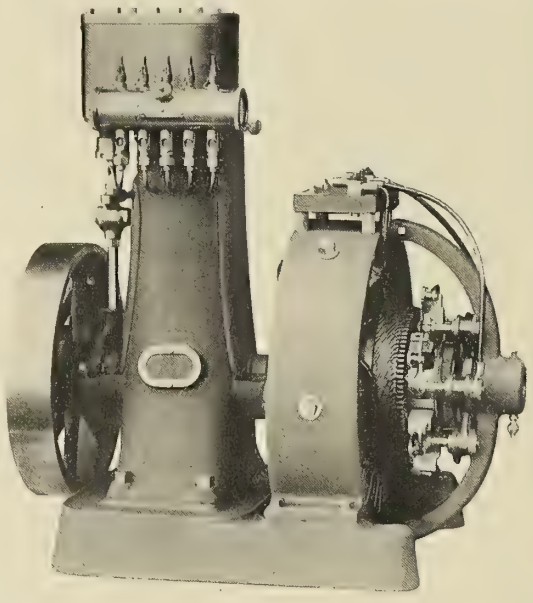
This book treats of the composition, analysis, utilization and valuation of coal. The data and descriptive matter given are largely based upon private notes and upon information scattered through books and the various publications in the engineering press. It is the intention of the author to present this data in such a form as to be readily applied and interpreted, and readily utilized by those who have an active interest in coal, which means practically everyone who is concerned with the generation of power. Three distinct classes of readers have been kept in mind in arranging the book, namely, the mechanical and power plant engineer, the chemical engineer and chemist, and the non-technically-trained business man and operator who has to do with the buying and selling of coal.

In attempting to present data which might be of interest and value to these different groups of readers a portion of the book will necessarily seem elementary to some and a portion will seem correspondingly technical to others. Good advice to each reader is to select that which may be of interest and value, and to pass over any other discussion or data which may appear too elementary or too technical for his needs. At all events the author has succeeded admirably in presenting his subject so as to meet the needs of such different classes of readers.

ENGINEERING SPECIALTIES

Electric Lighting of Dredges

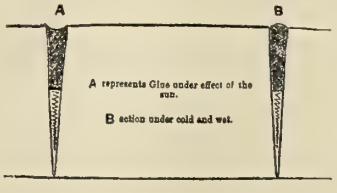
Recognizing the absolute need and convenience of electric lighting for dredging and excavating operations, the Bucyrus Company, Milwaukee, Wis., a prominent dredge building concern, has placed on the market a standard electric lighting set designed to meet these particular conditions. The set comprises a generator and engine mounted on a sub-base with brackets for mounting a rheostat and switches. The necessary wiring, lamps, cleats and other accessories are included with the set. The engine is of the vertical reciprocating type,



directly coupled to the generator, which is mounted on the same sub-base with the engine, a construction which it is claimed entirely eliminates the possibility of its working out of line besides making it a more compact unit. Both machines are of strong, rigid construction and highly efficient under operation. The generator is of a multi-polar direct-current type with radial brushes. The leads terminate at a board mounted upon insulators on top of the dynamo frame. The engine is equipped with sight feed lubricators and an automatic governor.

Marine Glue for Paying Deck Seams

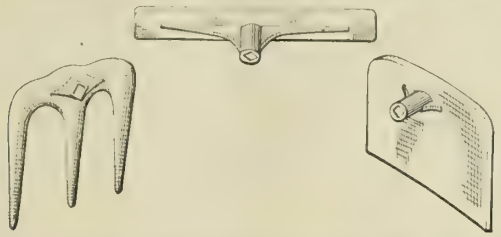
One of the most valuable qualities of marine glue for paying deck seams is its flexibility, as it allows the deck planking to contract and expand while still retaining its great adhesive power to the edges of the planks. The illustration shows how this effect takes place. It is claimed that 14 pounds of Jeffrey's



extra quality marine yacht glue will run from 200 to 250 feet of seam ¾ inch deep by ¼ inch wide. If properly used and not overheated it is said to last from four to six years in a seam, and has been known to last ten or twelve years. L. W. Ferdinand & Company, Boston, Mass., handle this glue.

Indestructo Fire Tools

It is a common complaint from the boiler room that the ordinary fire tools are unsatisfactory, in so far as their durability and wearing quality is concerned. In order to overcome this difficulty the Indestructo Fire Tool Company, Philadelphia, Pa., has brought out a set of fire tools of standard pattern but made of a new composition metal especially de-



signed to withstand the hard use to which such tools are subjected under particularly high temperature. Practically no change is made in the shape of the tools except that they are strengthened at the points most subject to wear, but the chief advantage claimed for them lies in the composition of the metal, which is a special high heat-resisting alloy capable of withstanding the hard usage to which such tools are put.

Prevention of Minor Accidents on Vessels

"It is cheaper to prevent accidents than to have them." A new force has been given this phrase by the activities of the American Museum of Safety, whose director, Dr. William H. Tolman, has made a thorough study of causes, costs and prevention of industrial accidents in this country and abroad. This matter is now generally well understood, and the question of prevention of accidents in minor forms is receiving careful attention. On board ship, however, the safety of employees and passengers has received less attention than should be given to a matter of such importance. While it is true that the *Titanic* disaster caused a very active interest in the question of life-saving when steamships are disabled or sinking, little has been done to make life and limb safer in ordinary day-in and day-out circumstances. For instance, in the engine and boiler rooms the possibility of slipping on the metal stair and ladder treads and floor plates, where oil is always present, is a very real danger. A metal has been produced, however, by the American Abrasive Metals Company, of New York, called "feralun," which has alundun grit cast in the surface, and which it is claimed is a practical preventative of slipping under all conditions, even when covered with oil. The safety ensured by the use of this metal in the stairs, ladders and platforms in the engine and boiler rooms of a vessel is evident, and its use could undoubtedly be extended with advantage to the passenger accommodations for similar purposes.

MAKE-UP OF TECHNICAL JOURNALS.—The publisher of INTERNATIONAL MARINE ENGINEERING appreciates very highly the compliment paid him by the publishers of *The American Machinist, Power, The Electrical World* and several other technical journals which began the year 1913 by adopting the general make-up of this magazine. When the size of INTERNATIONAL MARINE ENGINEERING was increased from 8 by 11 to 9 by 12 in January, 1905, we succumbed to commercial conditions and put advertising on the front cover in place of the Table of Contents. In order not to ignore the rights of subscribers we placed the Table of Contents on the first page of white paper immediately inside the cover. On the recommendation of a well-known eye specialist we adopted two columns to a page as far better for the eyes than three columns. This same rule applied to the advertising pages. Furthermore, we put the Buyers' Directory in the back part of the advertising pages and had it followed immediately by the Alphabetical Index to Advertisers, a general plan of make-up which, after waiting seven years, other publishers have wisely adopted.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

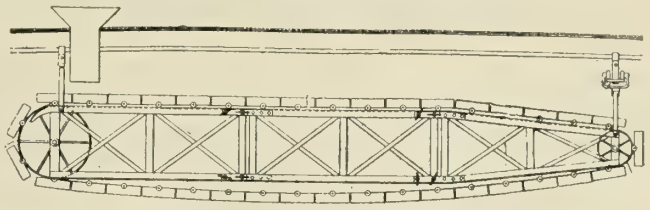
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,035,291. SUBMARINE SOUND-SIGNALING APPARATUS. EDWARD C. WOOD, OF SOMERVILLE, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

Claim 1.—An apparatus comprising a motor having a pressure chamber, an exhaust chamber, a fluid pressure operated controlling valve, an escape pipe, leading from said exhaust chamber, and also communicating with said valve, and means permitting the passage of fluid pressure through said pipe to said valve without entering said exhaust chamber, whereby said escape pipe serves also as means for transmitting fluid pressure impulses to said valve. Four claims.

1,038,588. APPARATUS FOR COALING SHIPS. MICHAEL S. IVERSON, OF NEW YORK, N. Y.

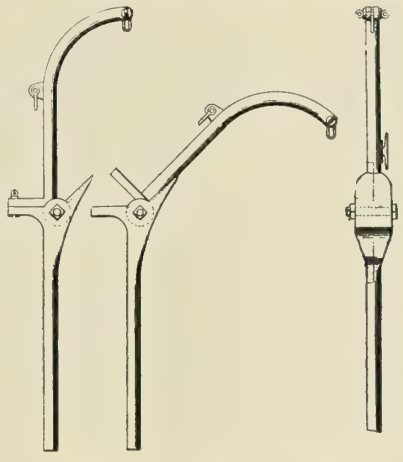
Claim 1.—In an apparatus for coaling ships, the combination of a conveyer, means for pivotally suspending the same at one end below a ship's deck to permit the conveyor to swing horizontally thereunder, an



arc-shaped track suspended from the deck at the other end of the conveyer and concentric with the pivotal support of the conveyer, a carriage running on said track and supporting the adjacent end of the conveyer, and means permitting adjustment of said track above the conveyer. Five claims.

1,040,822. BOAT DAVIT. CHARLES E. WATERWORTH, OF LAS CASCADES, CANAL ZONE.

Claim.—A boat davit comprising a vertical member having a pair of parallel ears and a socket intermediate the same, a curved upper member having an ear arranged in the socket, a pivoting bolt passing through said ears to pivotally connect said members, an angular supporting bearing carried by the first member and adapted to support the curved member at an obtuse angle to the first member, laterally extend-



ing supporting feet on said members adapted to abut each other when the members are in alinement, a locking pin passing through said feet and adapted to hold the feet together, a rope cleat carried by the curved member, and a lifting clevis carried by said curved member. One claim.

1,036,082. AUTOMOBILE TORPEDO. GREGORY CALDWELL DAVISON, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 2.—In an apparatus for generating motive fluid for automobile torpedoes, a casing forming a combustion chamber and having means for supplying a combustible and an oxygen-carrier to said chamber in combination with a carrier supporting an ignition fuse having a percussion cap, a spring-actuated striker for said cap, a latch for restraining the striker, and mechanism actuated by pressure in the combustion chamber to release the latch and allow the striker to strike the percussion cap. Six claims.

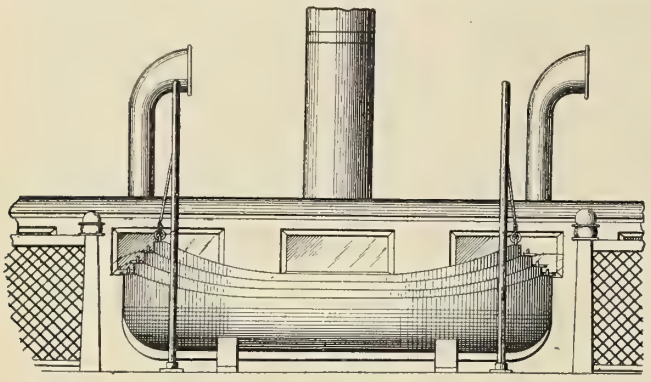
1,042,892. RELEASABLE-FLUKE ANCHOR. GEORGE E. CHAMPLIN, OF PAWTUCKET, R. I.

Claim 1.—A folding anchor comprising a shank having an enlarged head at one end thereof, the inner surface of said head being provided

with a plurality of lugs, a plate detachably secured to said lugs, said head and plate being provided with alined elongated slots, flukes pivotally mounted between said head and plate on opposite sides of said slots, and a locking block slidably mounted in said slots and adapted to engage said flukes for retaining the same in extended position. Four claims.

1,040,340. LIFE-BOAT. CHARLES JENKINS AND AMANDA A. JENKINS, OF PHILADELPHIA, PA.

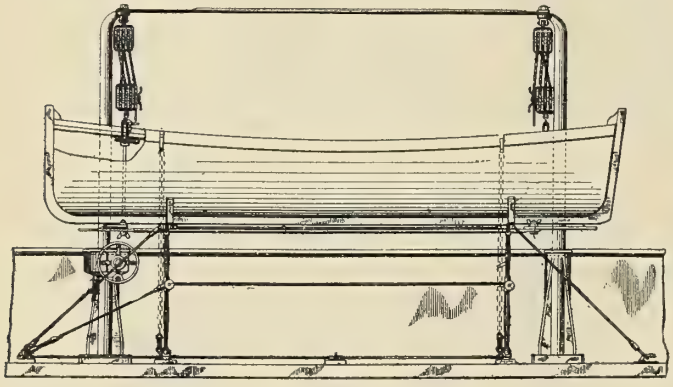
Claim 2.—The combination of a plurality of nested boats, each boat comprising a shell formed from a single sheet of metal, a keel integral with the boat, a portion of said keel V-shaped to receive the keel of another boat, the remaining portion of the keel formed of two thicknesses



of metal bent back upon each other, longitudinal brace bars at the inner edge of each boat, and angle iron bars secured to the inner face of the sides and bottom of each boat, each boat fitting into the next larger boat below, and supported on the bars therein, for the accommodation of seats and oars. Two claims.

1,040,741. APPARATUS FOR STOWING AND LAUNCHING SHIPS' BOATS. AREND R. NYBOER, OF EDAM, NETHERLANDS, ASSIGNOR TO GEORGE H. DIEHL, JR., OF NEW YORK, N. Y.

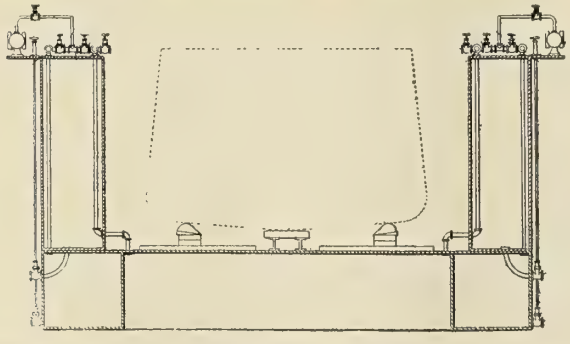
Claim 1.—A collapsible support for a ship's boat, comprising a frame hinged at its foot and hinged between its upper and lower ends, a chock at the upper end of the frame, a connection from the deck to the



frame at its upper end to hold the upper end in position and a connection from the deck to the frame between its ends to prevent the frame from collapsing. Twenty-five claims.

1,043,411. FLOATING DRY-DOCK. GUNNAR C. ENGSTRAND, OF TOMPKINSVILLE, N. Y.

Claim 1.—In a floating dry-dock, wings, a body, on which said wings are mounted, having fluid chambers provided with closed bottoms and supporting the dock when raised and fluid chambers provided with per-



manently open bottoms allowing the free passage of water into and from said chambers and means adapting air to be supplied to the open bottom chambers, to force water therefrom, to the supporting chambers in the body and adapting air to pass back and forth between the open bottom chambers and the supporting chambers in the body. Eight claims.

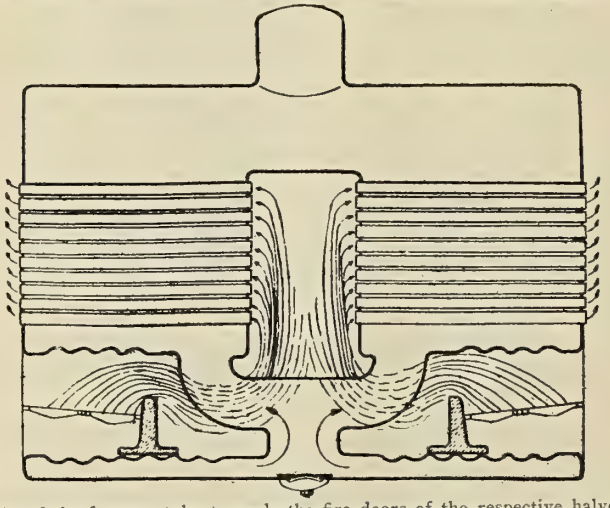
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Grays Inn Place, W. C., London.

22,218. MECHANISM FOR CLOSING AND LOCKING PORT HOLES AND OTHER DEVICES. W. V. GILBERT, OF 58 KENSINGTON HALL GARDENS, LONDON.

This invention relates to means for closing and locking portholes, etc., and consists in providing on a carrier stationary guide ribs with which the pin upon the locking member or ring engage, for the purpose of ensuring that the latter, which is turnably mounted upon the carrier, remains in a fixed position in relation to the carrier while it is being turned about its hinge by means of a handle, lever and link which, at the desired moment, rotate the locking member so that projections engage under the flanges, the pin meanwhile moving out of the guides through a gap.

10,465. IMPROVEMENTS IN MARINE BOILERS. E. KING, ZURICH, SWITZERLAND.

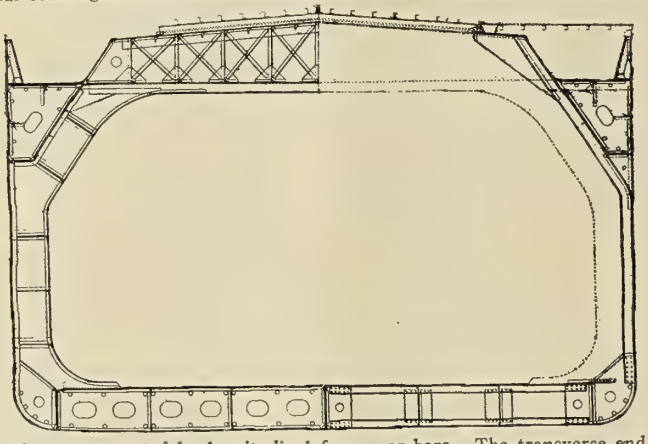
This invention relates to an improved marine boiler, comprising a shell, flame tubes, groups of fire tubes at the left and right-hand sides of the boiler, and a common combustion chamber in which the direction of the gases is changed. Two water circulating tubes extend longitudi-



nally of the furnace tube towards the fire doors of the respective halves of the boiler, from the upper part of the flame tube, and pass underneath the chamber. The tubes communicate with a single tube that extends through the lower part of the flame tube at a part about midway of its length.

25,595. IMPROVEMENTS IN SHIP CONSTRUCTION. SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD., OF NEWCASTLE-ON-TYNE, AND N. H. NURGESS, OF STOCKSFIELD-ON-TYNE.

This invention relates to the construction of a ship for carrying bulk cargo of the kind having the walls of its hold space inwardly inclined from about the water line to the level of the main hatchways and having water ballast tanks below the weather deck and outside the inclined portions of the walls, wherein the outer side or shell plating, the longitudinal coamings above the deck and the top or deck plating of the top side



tanks are supported by longitudinal frames or bars. The transverse end walls of the main hatchway are inclined, and transverse water ballast tanks are formed above the deck between the ends. The transverse tank top plating is extended over the inwardly extending brackets, knees and longitudinal beams to form a narrow deck or fore and aft gangway in way of the hatchways. Around the margins of the hatchways channel section bars are secured and the flanged lids or covers hinged to the sides of the hatchways when turned back, rest on the bulwarks so as to form discharging platforms.

14,775. TARPAULINS ON SHIPS' HATCHWAYS, ETC. J. VON RIEGEN, BREMERHAVEN, GERMANY.

For fixing tarpaulins over hatchways, a spring clamp adapted to be rotatably held in a fixed socket is provided. In order to maintain the clamp in position the rear end of its stem is provided with a projection bearing against a shoulder in the socket, but to allow of its withdrawal there is formed in the socket a groove through which the projection can pass.